Appendix A

Final Report

Development of Base and Future Year Emission Inventories for the Northern Ada County PM10 SIP Maintenance Plan

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Development of Base and Future Year Emission Inventories for the Northern Ada County PM10 SIP Maintenance Plan

Prepared for

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1.0 INTRODUCTION

1.1 BACKGROUND

The Boise metropolitan area is currently one of the fastest growing metropolitan regions in the nation with a population of over 400,000. It consists of two counties, Ada and Canyon, as well as the city of Boise with its population of 168,000. Four additional counties make up the remainder of a larger region known as the Treasure Valley. The rapid growth of the area, along with its topographical situation in the Boise River Valley, has caused a continuing potential for air pollution problems over the past thirty years. Stagnation periods during the winter, combined with extensive use of wood stoves for heating, have led to exceedances of air quality standards. Beginning with its designation by the federal government as an Air Quality Control Region in 1970, Idaho has continued to develop strategies to offset the air pollution problem. Pollutants of particular concern have been carbon monoxide and particulate matter. The northern portion of Ada County, Idaho, is unique in the nation in that it has no applicable federal PM_{10} standard. This came about as a result of EPA's revocation of the 1987 PM_{10} standard and subsequent national litigation that vacated the new PM_{10} standard. Although the EPA approved its current PM_{10} plan in 1996, the lack of an applicable federal PM_{10} standard caused uncertainties regarding conformity budgets and various environmental organizations filed suit. Settlement of this lawsuit will, among other conditions, require the State of Idaho to submit a PM_{10} Maintenance Plan by September 30, 2002. The maintenance plan requires a comprehensive emission inventory of all sources and pollutants contributing to PM_{10} concentrations in the nonattainment area. This report documents the methodologies used to develop base and future year emission inventories for the nonattainment area, and provides the resulting emission inventories.

This document and the emission inventories were prepared by ENVIRON International Corporation and its subcontractor Eastern Research Group, Inc. (ERG). The emission inventories were developed according to the methodologies and quality assurance/quality control (QA/QC) procedures documented in *Final Inventory Preparation Plan/Quality Assurance Plan* (IPP/QAP), prepared for the IDEQ, July 17, 2001 (ENVIRON, 2001). The IPP/QAP, which was reviewed by EPA-Region X staff, is based on U.S. EPA methods, such as those published in *Compilation of Air Pollutant Emission Factors, Volume I (AP-42), Fifth Edition* (U.S. EPA, January, 1995) and guidelines of the Emission Inventory Improvement Program (EIIP).

1.2 INVENTORY SCOPE

1.2.1 Pollutants

The pollutants included in the base and future year emission inventories include direct emissions of PM_{10}, as well as PM_{10} precursor emissions – ammonia (NH_3), nitrogen oxides (NO_x), sulfur oxides (SO_x), volatile organic compounds (VOCs), and carbon monoxide (CO).

1.2.2 Source Categories

The emission inventories consist of the four major source categories:

- Point sources are major stationary sources, defined as all facilities emitting greater than five tons per year (tpy) PM_{10} from a single stack. Point source emissions include combustion emissions, process emissions, material transfers, pile wind erosion, and paved and unpaved roads within facility grounds.

- Area sources are defined as all stationary sources (both anthropogenic and non-anthropogenic) that are not included in the point source inventory. These numerous facilities and activities include residential wood combustion, open burning, agricultural tillage and wind erosion, open area wind erosion, other fugitive dust, biogenic emissions, and VOC sources such as solvent usage, gasoline dispensing facilities, disperse sources of NH_3 such as cold storage facilities.

- On-road mobile sources include emissions from vehicles certified for highway use – cars, trucks, and motorcycles. In addition, fugitive road dust from paved and unpaved roads is included as part of the on-road mobile source emission inventory (though in some studies road dust is included in area sources).

- Off-road mobile sources encompasses a wide variety of equipment types that either move under their own power or are capable of being moved from site to site. Off-road mobile equipment sources, not licensed or certified as highway vehicles, are defined as those that move or are moved within a 12 month period and are covered under the EPA's emissions regulations as nonroad mobile sources. Off-road mobile sources include engines and equipment in the nine categories: agricultural, aircraft, airport ground support, construction and mining, industrial and commercial, lawn and garden, locomotives, recreational, and pleasure craft.

1.2.3 Geographical Domain

The geographical domain for the emission inventory effort is all of Ada and Canyon Counties in Idaho. The emission inventories were spatially allocated to 1-km by 1-km resolution for CAMx air quality dispersion modeling.

1.2.4 Temporal Resolution

The base year for the emission inventory development and air quality modeling is 1999. For air quality dispersion modeling, emissions were estimated for the December 20-26, 1999 episode. Annual emission inventories were also developed.

The December 20-26, 1999 episode is seven-day period beginning on a Monday. Temperatures for this period are shown in Figure 1-1. The figure shows that December 20-23 have similar temperatures; December 24 has lower temperatures; and December 25-26 have the lowest temperatures. For the emission inventory development, the episode period was modeled as three day types:

- December 20-23 weekdays;
- December 24, though a Friday, was modeled as a weekend day because it was a holiday and activity levels were assumed to be more reflective of weekend days than weekdays; and
- December 25-26, weekend days.

Figure 1-1 shows the hourly temperatures for the seven-day episode as recorded at the Boise Air Terminal. The hour-to-hour temperature variations were particularly "noisy," especially in the early morning hours, on all days of the episode. This noise had a large influence on the day-to-day averaging. In order to develop a representative daily temperature profile without undue noise, a 3-hour running average was first applied to each hour of the raw data as a filter. Average diurnal temperature profiles were then constructed for blocks of days with similar temperature ranges.

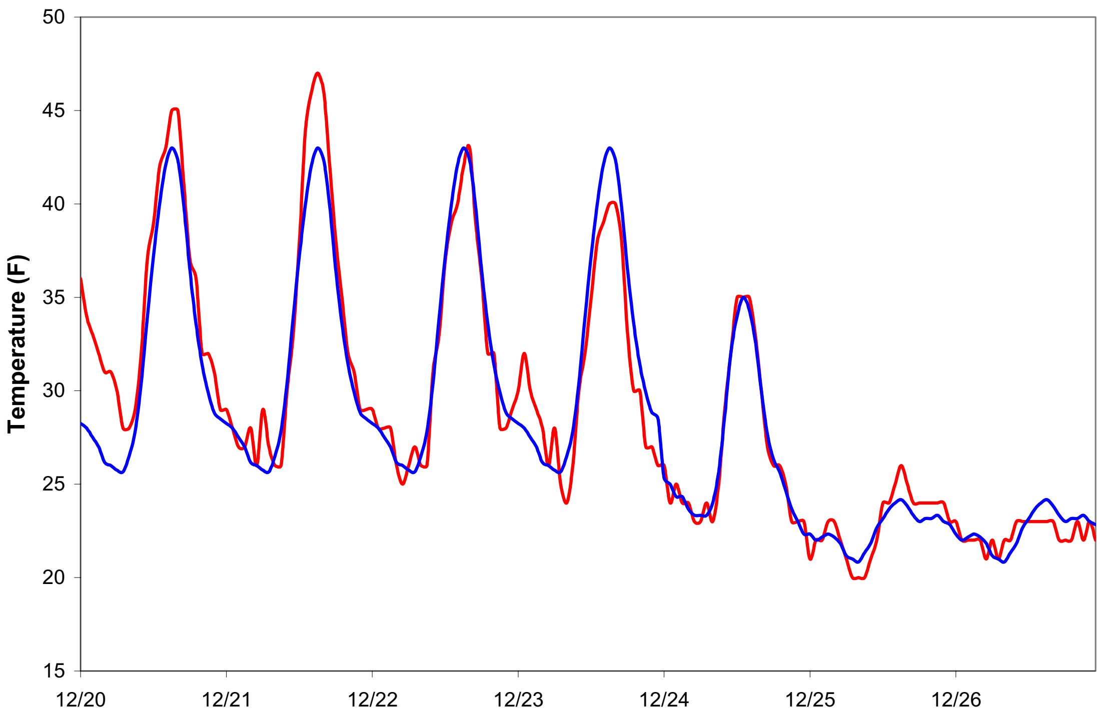

Figure 1-1. December 20-26, 1999 Boise Air Terminal hourly temperatures. Actual temperatures are shown red; average temperatures for the three day types are shown in blue.

Annual and episodic emission inventories were developed for three future years – 2010, 2015, and 2020. For the future year episodic emission inventories, meteorology from the worst-case episode was used. This episode was Jan 1-9, 1991, a 10-day period beginning on a Tuesday. Temperatures for this period are shown in Figure 1-2. Based on the observed temperatures, the episode period was divided into three day types with similar temperatures:

- January 1-4, weekdays with single-digit temperatures;
- January 5-6, weekend days; and
- January 7-9, weekdays with double-digit temperatures.

As for the 1999 episode, the recorded temperatures are "noisy," and were smoothed to develop the average temperature profiles for the three day types.

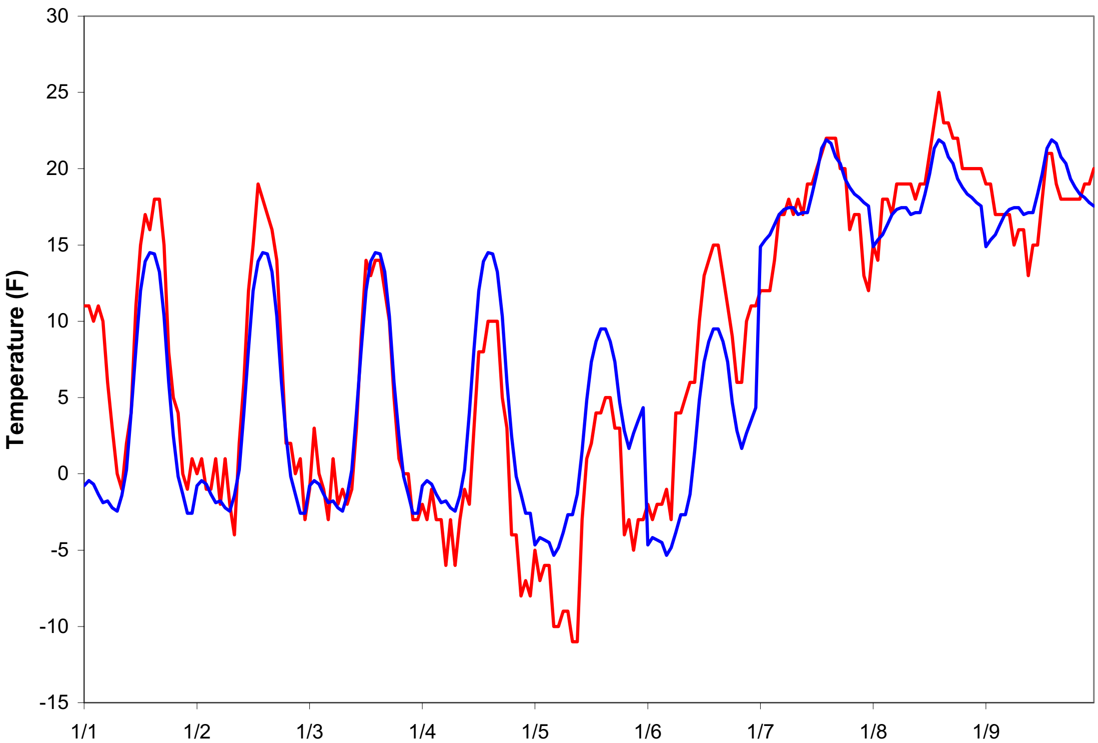

Figure 1-2. January 1-9, 1991 Boise Air Terminal hourly temperatures. Actual temperatures are shown red; average temperatures for the three day types are shown in blue.

2.0 1999 POINT SOURCES

Industrial point sources are defined as those facilities that emit pollutants that are located at specific stationary locations. The emissions may be either stack emissions or process-related fugitive emissions. For the 1999 Ada and Canyon County emissions inventory, major industrial point sources were defined as those sources with annual PM_{10} emissions greater than five tons per year (tpy) emitted from a single point located at the facility. However, since the data collection process resulted in data being collected for other, smaller point sources, all of these smaller facilities were included in the point source inventory. The steps taken to ensure there was no "double counting" of emissions within the area sources categories are discussed in more detail in Section 3.0 of this report. Also during the point source data collection, information was obtained that pertained to activity and emissions from some nonroad mobile equipment (e.g., dozers, front-end loaders, ground support equipment); these data were passed on to ENVIRON for inclusion in the nonroad equipment category.

The industrial point source inventory includes PM_{10}, NO_x, SO_x, NH_3, CO, and VOC emissions for the 1999 base year. Average annual and episodic daily (i.e., December 20-24, 1999 [weekday] and December 25-26, 1999 [weekend]) emission estimates including the effects of existing controls) were developed for each major industrial point source.

Details regarding the point sources data collection, emission estimation methodology, and QA/QC procedures are discussed in the remainder of this section.

2.1 DATA COLLECTION PROCEDURES AND RESULTS

The basis for data collection of point source emissions information was the point source questionnaire (PSQ). The PSQ was used to collect activity data pertaining to annual operation, episode operation (i.e., daily during the week of 20-26 December, 1999), and for purposes of determining "maximum potential to emit" (discussed in detail in Section 7.0 of this report). The design, use, and response rate to the PSQs are described below.

2.1.1 Point Source Questionnaire

The PSQ designed for this 1999 emissions inventory was based on a similar PSQ form developed for the previous 1995 emissions inventory effort (SAI, 1998). The 1999 inventory PSQ was organized by forms corresponding to the various components, processes, controls, and stacks emitting air pollutants at an industrial facility. These forms are described below; a complete set of PSQ forms is located in Appendix A.

- Form A: Facility information (e.g., facility name, address, Standard Industrial Classification [SIC], Universal Transverse Mercator [UTM] coordinates, etc.);
- Form B: Combustion equipment information (e.g., equipment type, size, rated capacity, maximum annual and 1999 annual fuel usage, etc.);
- Form C: Materials transport, handling, storage information (e.g., operation type [belt, pneumatic conveyor, storage pile, silo], transfer rates, storage capacity, etc.);

- Form D: General emission source information (e.g., operation description, production rates, etc.);
- Form E: Stack information (e.g., height, diameter, temperature, velocity, UTM coordinates, etc.);
- Form F: Emissions controls information (e.g., control code and description, pollutants and control efficiency by pollutant, reference for efficiency value, etc.);
- Form G: Emissions estimating (e.g., source type, control code, 1999 operating schedule by season/weekday/weekend day, pollutant emission factor, emissions estimate in pounds/year, etc.);
- Form H1: Fugitive dust emissions, transfer, conveying operations (i.e., 1999 operating schedule, PM_{10} emissions calculation, PM_{10} emissions in pounds/year);
- Form H2: Fugitive dust emissions, storage pile emissions (i.e., 1999 operating schedule, PM_{10} emissions calculation, PM_{10} emissions in pounds/year);
- Form H3: Unpaved industrial road emissions (i.e., 1999 operating schedule, PM_{0} emissions calculation, PM_{10} emissions in pounds/year);
- Form H4: Fugitive dust emissions, paved road emissions (i.e., 1999 operating schedule, PM_{10} emissions calculation, PM_{10} emissions in pounds/year);
- Form VOC: Evaporative VOC emissions (e.g., material type, quantity, solvent content, VOC emissions estimate in pounds/year, etc.);
- Form EPISODE: December 20-26, 1999 episode (i.e., source ID, daily hours of operation for the week, description of any abnormal operational conditions); and
- Form SUM: Emissions summary (i.e., source identification [ID] number, emissions of each pollutant in pounds/year for 1999, maximum potential emissions [either permitted limit or maximum allowed by operation capacity] of each pollutant in pounds/year).

Other contents of the PSQ packet included a set of instructions for completing the forms, and tables listing control codes and descriptions, and emission factors for selected sources.

On March 23, 2001, the PSQ packet was mailed to 144 facilities previously identified by DEQ during the 1995 inventory, and based on DEQ's knowledge of new facilities and facilities that have begun operations since the 1995 inventory as well as compliance and permit files. In addition, another 12 facilities that were required to submit emissions inventory data under the Title V Operating Permit program implemented by DEQ, were sent a separate PSQ packet on March 26, 2001. Finally, four facilities were subsequently identified and were send packets prior to May 1, 2001. A total of 160 facilities were mailed PSQ packets.

In order to facilitate data collection by some facilities, electronic versions of the PSQ packet were sent to these facilities via electronic mail (e-mail), and then were returned to DEQ in electronic format. Also, a database application was developed in Microsoft Access software that mirrored the PSQ forms was distributed to a few facilities to facilitate PSQ submittal. In addition, a master point source database was developed as a repository for the information returned via the PSQ.

2.1.2 PSQ Responses

The operating status of the 160 facilities who received packets is as follows:

- 123 facilities operated during 1999;
- 25 facilities were either not in operation during 1999, not a point source (e.g., corporate headquarters, distribution center, etc.), not located in either Canyon or Ada County, or the PSQ was returned; and
- 12 facilities that did not operate during 1999 but did operate in following years (i.e., emissions will be included in the projections of future year emissions described below in Section 7.0 of this report).

Completed PSQ packets (either in hard copy or electronic format) were returned to DEQ, and then these were mailed to ERG for QA/QC, data entry, and additional processing associated with estimating emissions.

2.2 EMISSION CALCULATION METHODOLOGY

The methods recommended by U.S. EPA in *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition (AP-42)* (U.S. EPA, 1995) were used to estimate emissions. Each facility that received a PSQ was required to estimate emissions from all process and fugitive sources located within the facility according the methods described on the forms.

Annual emissions for each type of source (i.e., process, combustion, or fugitive dust) were estimated in terms of pounds/year. (These estimates were made by each facility and recorded on the appropriate forms, then checked by ERG during the QA/QC process). Next, daily emissions for the December 20-26, 1999, episode were estimated by ERG using the schedule submitted by the facility on FORM EPISODE. Details of the methods and data used to estimate annual and daily emissions are described below.

2.2.1 Combustion and Process Sources – Annual Emissions

For combustion and process (e.g., milling, etc.) sources, emissions were calculated using the following general equation:

$$E = A \times EF \times \left(1 - \frac{C}{100}\right)$$

where:

E = emissions (pounds/year);
A = activity level (activity units/year);
EF = emission factor (pounds/activity unit); and
C = overall control efficiency.

In order to assist sources with their completion of the PSQ, the packet included a list of Standard Classification Code (SCC)-specific emission factors along with instructions regarding the use of these factors. These SCC-specific emission factors were extracted from U.S. EPA's Factor Information Retrieval Data System (FIRE) Version 6.23 (USEPA, 2000). If the facilities had source-specific information (e.g., continuous emission monitoring [CEM] measurements, source test measurements, etc.), then emissions could be alternatively estimated using this information rather than the SCC-specific emission factors; however, most facilities used the emission factors.

A sample calculation using this equation for estimating NO_x emissions from a drum mix asphalt plant, natural gas-fired dryer (i.e., SCC 3-05-002-55) is as follows:

where:

A = 42,300 tons of hot mix asphalt (HMA) produced per year (ton/year);
EF = 0.026 pounds of NO_x per ton of HMA (from AP-42, Table 11.1.7);
C = 95% (based on engineering estimate provided by facility); and
E = 42,300 x 0.026 x (1 – 95/100) = 55 pounds of NO_x per year.

2.2.2 Fugitive Dust Sources – Annual Emissions

The PSQ packet also provided instructions regarding the use of the fugitive dust data collection forms. The methodologies used on the questionnaires for these fugitive dust sources are summarized below.

2.2.2.1 Wind Erosion of Storage Piles

Several methods have been developed to estimate wind erosion emissions from open aggregate storage piles and exposed areas. The method presented in AP-42 is the most rigorous. However, it requires separate estimation of emissions for every time period between disturbances to the pile. In addition, the method requires actual meteorological data for the time period between disturbances (i.e., fastest mile wind speed data). AP-42 states that since the erosion potential is highly nonlinear function of the fastest mile wind speed, mean values of the fastest mile wind speed are inappropriate to use. Also, the resulting calculation will only be valid for periods as long or longer than the period between disturbances. As a result, the less complicated method described below, which was developed to estimate emissions for continuously active storage piles, was used (U.S. EPA, 1988).

The emission estimation equation for wind erosion from storage piles is as follows:

$$E = 0.85 \times A \times n \times \left(\frac{s}{1.5}\right) \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) \times \left(1 - \frac{C}{100}\right)$$

where:

E = emissions of PM_{10} (pounds/year);
A = size of the pile (acres);
n = number of days per year the pile is continuously active;
s = silt content of the aggregate (percent);

p = number of days per year with 0.01 inches or more of precipitation;
f = percentage of time that the unobstructed wind speed exceeds 12 mph at the mean pile height; and
C = overall control efficiency (percent).

It should be noted that the use of the above equation provided a conservative estimate of the annual emissions of storage piles.

A simplified version of this equation, incorporating 1999 precipitation and wind speed data is as follows:

$$E = 1.214 \text{ x } (A) \text{ x } (n) \text{ x } (s) \text{ x } (1 - C/100)$$

A sample calculation using the simplified equation for estimating PM_0 emissions from a storage pile is as follows:

where:

A = 40 acres (recorded on PSQ);
n = 365 days (recorded on PSQ);
s = 0.15 (based on engineering estimate provided by facility);
C = 50% (water spray); and
E = 1.214 x 40 x 365 x 1.5 x (1 – 50/100) = 13,293 pounds of PM_{10} per year.

Although this equation provides estimates of annual emissions (based on annual activity, meteorological data, etc), it was assumed that daily emissions on days with no hourly wind speeds exceeding 12 mph were zero. Thus, it follows that since wind speeds were less than 12 mph on each day of the episode (December 20-26, 1999) emissions from wind erosion of storage piles were zero. This is explained further in Section 2.2.3. If desired, facilities also could estimate emissions using the more rigorous methodology listed in AP-42, Chapter 13.2.4; however, most facilities used the equation shown above. Also, in some cases facilities chose to use an alternative emission factor that was provided in Table 2 of the instructions (e.g., 1.329 pounds of PM_{10} per acre-year).

Recommended control efficiencies for typical fugitive dust control techniques, such as enclosure of storage areas and wet suppression, were included in the PSQ instructions.

2.2.2.2 Loading and Unloading Operations

Particulate emissions from loading and unloading operations from the storage piles occur during both storage loading and load-out of material for shipment or for return to the process stream. The loading and unloading process usually involves dropping the material onto a receiving surface; the drop operation may be either batch or continuous. Truck dumping on the pile or loading out from the pile to a truck with a front-end loader are examples of batch drop operations. Adding material to the pile by a conveyor is an example of a continuous drop operation. The quantity of particulate emissions generated by either type of drop operation may be estimated with the following equation (AP-42, Chapter 13.2.4):

$$E = 0.00112 \times \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \times \left(1 - \frac{C}{100}\right) \times T \times D$$

where:

E = emissions of PM_{10} (pounds/year);
U = mean wind speed (mph);
M = material moisture content (percent);
C = overall control efficiency (percent);
T = daily throughput (ton of material transferred per day); and
D = days per year operating (day).

A simplified version of this equation, incorporating 1999 precipitation and wind speed data is as follows:

E = 0.0054 x T x D x (1/M)^1.4 x (1 – C/100)

A sample calculation using the simplified equation for estimating PM_0 emissions from a storage pile is as follows:

where:

T = 960 tons (from PSQ);
D = 208 days (from PSQ);
M = 2% (from PSQ);
C = 0 (no control); and
E = 0.0054 x 960 x 208 x (1/2)^1.4 = 409 pounds of PM_{10} per year.

2.2.2.3 Unpaved Industrial Roads

Fugitive dust emissions from unpaved industrial roads are due to the force of vehicle wheels traveling on an unpaved road causing pulverization of surface material and wake turbulence caused by a vehicle. The following expression was used to estimate PM_0 emissions from unpaved roads (AP-42, Chapter 13.2.2).

$$E = \frac{2.6\left(\frac{s}{12}\right)^{0.8}\left(\frac{W}{3}\right)^{0.4}}{\left(\frac{M}{0.2}\right)^{0.3}} \times \left(\frac{S}{15}\right) \times \left(\frac{365 - p}{365}\right) \times D \times T \times d \times \left(1 - \frac{C}{100}\right)$$

where:

E = emissions (pounds PM_{10}/year);
s = surface material silt content (percent);
W = mean vehicle weight (tons);
M = surface material moisture content (percent);

S = mean vehicle speed (if mean vehicle speed > 15 mph, then set S = 15) (mph);
p = number of days per year with 0.01 inches or more of precipitation;
D = distance per round trip (miles);
T = daily round trips;
d = vehicle activity (days/year); and
C = overall control efficiency (percent).

Default values for the variable "s," the silt content of the unpaved road surface, are provided in AP-42 for a number of different industries. These default values were also provided with the PSQ instructions.

A simplified version of this equation, incorporating 1999 precipitation and wind speed data is as follows:

$$E = 0.0074 \text{ x } \frac{s^{0.8} \text{ x } W^{0.4}}{M^{0.3}} \text{ x S x d x T x D x } \left(1 - \frac{C}{100}\right)$$

A sample calculation using the simplified equation for estimating PM_0 emissions from an unpaved road is as follows:

where:
s = 4.8% (from PSQ);
S = 10 mph (from PSQ for a dozer);
W = 20 tons (from PSQ);
M = 3% (from PSQ);
d = 250 days per year of activity (from PSQ);
T = 6 round trips per day (from PSQ);
D = 1 mile per round trip (from PSQ);
C = 50% (water spray on road approximately 3 times per day); and
E = 0.0074 x (((4.8)^0.8 x (20)^0.4)/(3)^0.3) x 10 x 250 x 6 x 1 x (1-50/100)
= 464 pounds of PM_{10} per year.

2.2.2.4 Paved Industrial Roads

Fugitive dust emissions from paved industrial roads occur when vehicles travel over a paved surface, such as a road or parking lot. Emissions originate from the loose material present on the road surface. At industrial facilities, surface loading is replenished by spillage of material and track out from unpaved roads and staging areas. The following expression was used to estimate PM_{10} emissions from paved roads (AP-42, Chapter 13.2.1):

$$E = 0.016 \times \left(\frac{L}{2}\right)^{0.65} \times \left(\frac{W}{3}\right)^{1.5} \times D \times T \times d \times \left(1 - \frac{C}{100}\right)$$

where:
E = emissions (pounds PM_{10}/year);

L = road surface silt loading (g/m^2);
W = mean vehicle weight (tons);
D = distance per round trip (miles);
T = daily round trips;
d = vehicle activity (days/year); and
C = overall control efficiency (percent).

Default values for the variable L, the road surface silt loading, have been defined in AP-42 for a number of different industries. These values were provided with the PSQ instructions.

A simplified version of this equation, incorporating 1999 precipitation and wind speed data is as follows:

$$0.002 \text{ x } L^{0.65} \text{ x } W^{1.5} \text{ x } D \text{ x } T \text{ x } d \text{ x } \left(1 - \frac{C}{100}\right)$$

A sample calculation using the simplified equation for estimating PM_{10} emissions from an unpaved road is as follows:

where:
L = 70 (from PSQ);
W = 20 tons (from PSQ for a dump truck);
T = 6 round trips per day (from PSQ);
D = 2 mile per round trip (from PSQ);
d = 250 days (from PSQ);
C = 0 (no control)); and
E = 0.002 x (70)^0.65 x (20)^1.5 x 2 x 6 x 250 = 8,492 pounds of PM_{10} per year.

2.2.3 Episode Daily Emissions

As mentioned above, the facilities completed a Form EPISODE indicating the hours of operation, by source, during each day of the December 20-26, 1999, episode. These hours of operation, along with the annual emissions estimates, were used to estimate daily emissions on each day of the episode.

An important issue related to the daily emissions estimates was to include the impact of meteorological conditions that occurred during the episode. Relevant meteorological conditions affecting emissions from industrial point sources during that time period were as follows:

- Wind speed was 0 mph during every hour on December 26;
- Wind speed was less than 12 miles per hour (mph) during every hour of every day from December 20 through 26; and
- Trace precipitation (less than 0.01 inch) occurred on December 24, 25, and 26, in combination with snow, mist, and freezing fog.

Based on the emission methodologies for fugitive dust sources (transfers and conveying) the effect of no measurable wind speed would be zero emissions (i.e., on December 26). Also, storage pile wind erosion emissions would have been zero on days with all hourly wind speeds less than 12 mph (i.e., all days during the episode). Finally, it was assumed that all fugitive dust emissions (i.e., transfer and conveying operations; storage pile wind erosion; and, paved and unpaved industrial roads) would have been zero on days with wet conditions (i.e., trace precipitation, snow, mist, and freezing fog on December 24-26, 1999).

The specific procedure used to estimate daily emissions is described below, including additional discussion on how the meteorological conditions were assessed. It should be noted that this methodology was submitted to U.S. EPA, Region 10, and approved, prior to using it in the emissions inventory effort for Ada and Canyon counties.

- Step 1: Begin with annual inventory file comprising estimates recorded from Forms G, H, and VOC
- Step 2: Delete records for sources that did not operate during the episode
- Step 3: Delete records for sources on Form H2 (i.e., no wind erosion emissions during the episode)
- Step 4: Determine "weekday hours/day" (i.e., normal weekday operations from Form EPISODE) on Monday through Friday
- Step 5: Determine "weekend hours/day" (i.e., normal weekend operations from Form EPISODE) on Saturday and Sunday
- Step 6: Calculate "pounds emissions in winter" as (1999 pounds/year) x (% operation in winter season)
- Step 7: Calculate "hours operated in winter" as [(weekday hours/day) x 64 days x (normal number of weekdays worked)/5] + [(weekend hours/day) x 26 days x (normal number of weekend days worked)/2]
- Step 8: Calculate "winter average pounds/hour" as (pounds emissions in winter)/(hours operated in winter)
- Step 9: Calculate "daily emissions on December 20" as winter average pounds/hour x hours operated on December 20
- Step 10: Calculate "daily emissions on [other days]" as repeat previous step for other days
- Step 11: Delete records for sources on Forms H1, H3, and H4 for December 24-26 (i.e., zero emissions due to effect of precipitation).

The result of this procedure was a database of emissions in pounds/day for sources that operated during the episode week. Impacts from low or zero wind speed, and the effect of precipitation were incorporated into the estimate as described.

2.3 EMISSIONS BY FACILTY

Table 2-1 shows the results of the 1999 annual emissions inventory for point sources that operated in Ada and Canyon Counties. Facilities are listed based on the total PM_0 emissions, with the largest emitter first. Total 1999 PM_{10} emissions for these sources equal 1,172.6 tons. The largest emitter of PM_{10}, NO_x, and SO_x, CO, and NH_3 is the Amalgamated Sugar Company

(TASCO) facility in Nampa (Canyon County). The next highest emitter of PM_{10} is the J.R. Simplot facility in Caldwell (Canyon County). The combined annual PM_{10} emissions from these two facilities (545.3 tons) comprise nearly half (i.e., 46.5%) of the total annual PM_{10} emissions inventory for Ada and Canyon Counties combined.

Tables 2-2a through 2-2f show the daily emissions by pollutant during the 1999 episode for each point source facility for PM_{10}, NO_x, and SO_x, VOC, CO, and NH_3, respectively. Facilities are listed based on the amount of emissions on December 20, 1999, with the largest emitter first. TASCO emitted the most PM_{10}, NO_x, SO_x, CO, and NH_3 on each of the 7 days of the episode.

2.4 DATA MANAGEMENT AND QUALITY ASSURANCE/QUALITY CONTROL

The completed PSQs were input into an Access database for storing and reporting purposes. The PSQs that were returned in database format were imported in the point source database thus avoiding the data entry step. This database was designed with input screens that mirrored the individual PSQ forms (e.g., Form A, Form SUM, etc.) to facilitate easy and error-free data entry. A master table was populated, and queries were run to summarize data in various ways for QA/QC and reporting. Once final, the master table was converted to Microsoft Excel, and provided to ENVIRON for model pre-processing. Separate worksheets reported annual, and episode (daily) emissions.

In general, procedures described in *Final Inventory Preparation Plan/Quality Assurance Plan (IPP/QAP)* (ENVIRON, 2001) were used to check, and correct when necessary, the point source emissions inventory data and emissions estimates. The checklists used to QA/QC the PSQs and the resulting database are located in Appendices 2A and 2B, respectively. The QA/QC procedure used for the point sources data is summarized as follows:

- Initial review of PSQs for completeness. This included checking for missing forms, and missing data in required fields (e.g., location coordinates, emission factors, etc.). As necessary, facility points-of-contact were contacted by ERG to provide any missing data.

- Accuracy review of PSQs. This included checking the Form A listing of sources, and making sure that a description form (i.e., either Form B, C, or D) was included for each source, and that stack and control forms (i.e., Forms E and F) were included, if applicable. Each emissions calculation form (i.e., Forms G or H1-H4, as applicable) was checked for accurate emission factors. The emissions provided by the facility on the Forms G and/or H1, H2, H3, or H4 were re-calculated and changed as appropriate. Facilities were contacted when large discrepancies occurred on the G/H1-H4 forms. The SUM form was checked to ensure that emissions from all sources within the facility were recorded on the form. Also, the PTE estimates were checked and changes were made as appropriate.

- Data entry review. After each facility's PSQ was entered into the database, the hard copy PSQs were compared to the data entry screens or printouts. Data entry errors were corrected when encountered.

- Accuracy review of point source database (i.e., inventory results). After all PSQ data were entered into the point sources database and data entry was checked, database queries were generated to check for completeness and accuracy in the database. For example, missing facilities were checked for by comparing the facilities in the database to the original PSQ mailing list. Missing forms (e.g., EPISODE and SUM forms) were checked for, along with missing data in some fields (e.g., Standard Industrial Classification [SIC] codes, daily and seasonal operating schedules, etc.). Emissions were checked by summing the emission totals from the calculation forms (i.e., Forms G or H1-H4) and comparing to the pollutant totals on the SUM form. All errors were corrected when encountered.

  A common error that was found was use of emission factors from the 4^{th} Edition of AP-42 instead of from the most current 5^{th} Edition. In most cases, the 5^{th} Edition emission factors were less than the 4^{th} Edition emission factors for the same sources/pollutants. Another common error was use of inconsistent units for the throughput and emission factors (e.g., selecting units of throughput of 1,000 gallons on the PSQ form instead of gallons resulting in emissions that were overestimated by a factor of 1,000).

A final check for completeness and accuracy was a peer review by the facilities of the draft point sources emissions inventory. DEQ distributed a table of results for review by the facilities, and then upon request, detailed spreadsheets with source-by-source results were provided to the facilities. As a result of this review, changes were made to inventory results for three facilities. One facility erroneously reported a VOC control efficiency of 35% that should have been 86%; the other two facilities reported erroneous 1999 fuel consumption units, resulting in an overestimate of emissions by a factor of 1,000. All errors were corrected and the database was finalized.

Table 2-1. 1999 point sources annual emissions by facility (tons).

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
The Amalgamated Sugar Company LLC - Nampa	Canyon	335.8	1188.1	1557.2	29.8	1570.8	381.3
J.R. Simplot Company - Caldwell	Canyon	209.5	128.2	91.0	43.0	137.5	0.0
Woodgrain Millwork	Canyon	61.0	0.6	0.0	1.2	0.3	0.0
C. Wright Construction	Ada	38.4	0.0	0.0	0.0	0.1	0.0
J. R. Simplot Company, Nampa Potato Plant	Canyon	36.8	19.8	0.1	47.7	16.0	0.5
Micron Technology	Ada	31.8	30.3	0.6	99.0	28.5	10.2
ConAgra Beef Company	Canyon	28.4	9.9	0.1	0.5	8.4	1.4
Hidden Hollow Landfill	Canyon	19.7	4.6	0.3	19.4	6.0	0.0
Rock Contractors, Inc.	Canyon	19.4	3.1	0.2	0.2	0.7	0.0
Mike's Sand and Gravel	Ada	18.5	0.0	0.0	0.0	0.0	0.0
SSI Food Svc	Canyon	18.0	16.8	0.1	0.9	14.1	0.5
Chevron Pipeline Boise	Ada	17.8	5.1	0.0	209.5	13.7	0.0
LP Wood Polymers, Inc.	Ada	15.0	3.1	0.0	2.9	1.2	0.0
Plum Creek Northwest Lumber, Inc.	Ada	14.7	0.0	0.0	0.0	0.0	0.0
Simplot-Wst.Stock.	Canyon	14.7	1.9	0.0	0.1	1.6	0.0
Central Paving PRC	Ada	14.7	16.9	1.1	0.0	3.6	0.0
Monroc Concrete	Ada	13.4	0.6	0.0	0.0	0.5	0.0
Low's Ready Mix, Inc. - Star West Facility	Canyon	12.4	13.4	0.9	1.1	2.9	0.0
Rambo Crushing Co.	Canyon	12.2	23.9	1.6	2.0	5.1	0.0
Boise Paving PRC	Ada	11.1	0.0	0.0	0.0	0.0	0.0
Summit Stone	Ada	10.7	23.7	1.6	0.0	5.1	0.0
Central Paving, Inc. #2	Ada	10.5	1.9	0.2	1.3	4.6	0.0
Monroc-Boise Facility	Ada	10.3	0.2	0.8	0.0	0.1	0.0
Boise Cascade Container	Canyon	10.0	1.1	0.0	7.2	3.0	0.1
Boise Paving HMA	Ada	9.7	2.5	18.6	15.6	12.5	0.0
Nampa Paving & Asphalt Co.	Canyon	7.6	1.9	0.4	2.3	9.4	0.0
Consolidated Concrete Company (Aspen Rd.)	Ada	7.2	0.0	0.0	0.0	0.0	0.0
Unaga-Eusti Enterprises, Inc. (G&B Redi)-Star Pit	Canyon	6.9	9.8	0.2	0.3	2.6	0.0
Monroc-Nampa	Canyon	5.8	0.0	0.0	0.0	0.0	0.0
Darling International Inc.	Ada	5.6	5.8	0.4	2.0	5.6	0.5
Turner Sand and Gravel-Boise	Ada	5.4	0.0	0.0	0.0	0.0	0.0
Builders Masonry Products	Ada	5.4	0.8	0.0	0.1	0.7	0.0
Croman Corporation	Ada	5.2	5.9	0.0	0.2	3.5	0.1
Westfarm Foods-Caldwell	Canyon	5.1	15.8	0.1	1.2	10.9	4.2
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	5.1	0.0	0.1	0.9	0.0	0.0
Low's Ready Mix, Eagle	Ada	4.9	0.0	0.0	0.0	0.0	0.0
Canyon Sand and Gravel, Inc.	Canyon	4.7	11.4	1.9	0.3	3.1	0.0
American Paving Company	Ada	4.6	2.8	0.6	1.6	6.5	0.0
IBP	Ada	4.6	9.5	0.1	1.8	7.8	0.3
Nelson-Deppe Inc. - Ada	Ada	4.5	8.1	0.5	0.0	1.7	0.0
Nelson Const. Co.-Amity(777-00208)	Ada	4.5	0.9	0.0	0.5	1.4	0.0
Bowman Sand and Gravel	Canyon	4.3	2.2	0.1	0.0	0.5	0.0
Nelson-Deppe Inc. - Canyon	Canyon	4.2	7.5	0.5	0.0	1.6	0.0

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
Pacific Press Publishing Association	Canyon	4.0	0.6	0.0	12.0	0.1	0.0
Western World, Inc. Circle J Trailers	Canyon	3.9	0.0	0.0	42.9	0.0	0.0
Nelson Const. Co.-Eagle Island	Ada	3.8	9.7	1.5	0.2	2.6	0.0
Clements Concrete	Ada	3.7	0.0	0.0	0.0	0.0	0.0
Motivepower, Inc. Apple Street	Ada	3.5	3.1	0.0	22.7	2.6	0.0
Trus Joist Product Development Center	Ada	3.1	0.0	0.0	0.0	0.0	0.0
Prime Earth	Ada	3.1	8.5	0.6	0.7	1.9	0.0
Sawtooth Forest Products	Canyon	2.9	0.0	0.0	0.0	0.0	0.0
Sorrento Lactalis	Canyon	2.9	2.8	0.0	0.4	5.8	0.0
Fleetwood Homes	Canyon	2.8	0.0	0.0	22.9	0.0	0.0
Nelson Construction Co.	Canyon	2.7	6.4	1.0	0.2	1.7	0.0
Centerlane Paving, LLC	Ada	2.7	20.5	10.4	2.6	9.5	0.0
Crookham	Canyon	2.6	0.0	0.0	0.0	0.0	0.0
Idaho Sand & Gravel	Canyon	2.6	3.4	3.6	2.0	8.0	0.0
Idaho Concrete Company	Canyon	2.6	0.0	0.0	0.0	0.0	0.0
Can-Ada Crushing	Ada	2.6	17.5	2.7	0.0	4.6	0.0
Nelson Const. Co.-Pleasant Valley	Ada	2.3	3.8	0.6	0.1	1.0	0.0
Boise Paving PRC2	Ada	2.2	7.2	0.5	0.0	1.6	0.0
West Boise WWTF	Ada	2.1	38.4	3.1	2.4	6.0	1.2
Central Paving, Inc. #1	Ada	1.9	3.7	0.4	3.3	8.9	0.0
Idaho Asphalt	Canyon	1.8	5.1	0.0	2.6	4.3	0.2
Simplot AgriSource - Nampa	Canyon	1.7	0.0	0.0	0.0	0.0	0.0
Western Construction-Crusher #00042	Canyon	1.7	0.7	0.1	0.0	0.2	0.0
Snake River Chemicals, Inc.	Canyon	1.6	0.0	0.0	0.0	0.0	0.0
Motivepower, Inc., Branniff Street	Ada	1.5	45.1	3.0	4.0	10.7	0.0
Ruschman Sand and Gravel, Inc.	Ada	1.4	0.0	0.0	0.0	0.0	0.0
Nelson Const. Co.-Amity	Ada	1.4	2.7	0.4	0.1	0.7	0.0
Monroc-Middleton	Canyon	1.3	0.0	0.0	0.0	0.0	0.0
Nelson Const. Co.-Middleton	Canyon	1.0	2.7	0.4	0.1	0.7	0.0
Castle Wood Products	Ada	1.0	1.1	0.1	0.1	0.2	0.0
Evans Grain, Feeds & Seed Co.	Canyon	0.9	0.0	0.0	0.0	0.0	0.0
Nelson Const. Co.-Flying Wye(777-00226)	Ada	0.8	1.6	0.3	0.0	0.4	0.0
Western Construction, Inc. - 00098	Canyon	0.8	0.5	0.0	0.0	0.1	0.0
Western Electronics LLC	Ada	0.7	0.1	0.0	0.0	0.0	0.0
Nelson Const. Co.-Flying Wye	Ada	0.7	1.4	0.2	0.0	0.4	0.0
Nelson Const. Co.-Diamond	Ada	0.7	1.7	0.3	0.0	0.4	0.0
Koch Materials Company	Ada	0.6	2.5	0.0	8.3	2.1	0.1
MCMS, Inc.	Canyon	0.6	0.3	0.0	7.6	0.3	0.0
Seminis Veg. Seeds	Canyon	0.5	0.9	0.0	6.6	0.8	0.0
Nelson Const. Co.-AD111	Ada	0.4	1.6	0.3	0.0	0.4	0.0
Clayton's Calcium, Inc.	Ada	0.4	0.0	0.0	0.0	0.0	0.0
Idaho Truss & Component Company	Ada	0.3	0.0	0.0	0.0	0.0	0.0
Harris Moran Seed Co.	Canyon	0.3	1.4	0.0	0.2	2.3	0.0
Lander St. WWTF	Ada	0.3	4.7	3.9	0.9	3.2	0.2
Idaho Air National Guard	Ada	0.3	3.2	0.0	6.6	2.0	0.0
Boise Airport	Ada	0.3	0.1	0.0	0.2	0.0	0.0

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
Westfarm Foods-Boise	Ada	0.3	1.8	0.5	0.2	3.0	0.1
Zamzow's Feed Mill	Ada	0.2	0.1	0.0	0.0	0.1	0.0
Zilog, Inc.	Canyon	0.2	2.4	0.0	24.1	1.9	3.0
Zilog Inc.	Canyon	0.2	2.1	0.0	19.8	1.7	0.5
Hewlett Packard Company	Ada	0.1	2.0	0.1	46.3	0.7	0.0
Double D Feed and Seed	Canyon	0.1	0.0	0.0	0.0	0.0	0.0
Syngenta Seeds, Inc.-Nampa Plant	Canyon	0.1	1.7	0.0	0.0	0.2	0.0
White's Hauling & Farm	Canyon	0.1	0.0	0.0	0.0	0.0	0.0
Fiberglass Systems	Ada	0.1	0.0	0.0	99.0	0.0	0.0
Double D Service Center	Ada	0.1	0.0	0.0	0.0	0.0	0.0
Great American Appetizers	Canyon	0.0	0.6	0.0	0.1	0.5	0.0
Northwest Pipeline	Ada	0.0	2.1	0.1	0.1	0.1	0.0
Superior Steel Products, Inc.	Canyon	0.0	0.0	0.0	1.2	0.0	0.0
Teton Sales Company	Canyon	0.0	0.4	0.0	73.6	0.2	0.0
Micronpc.com	Canyon	0.0	0.5	0.0	0.0	0.1	0.0
Atlas Pallet Co.	Canyon	0.0	0.0	0.0	0.0	0.0	0.0
Cloverdale Funeral Home	Ada	0.0	0.2	0.0	0.0	0.0	0.0
EPSCO Corp.	Ada	0.0	0.0	0.0	1.2	0.0	0.0
Riverside Crematory	Ada	0.0	0.1	0.0	0.0	0.0	0.0
Alden's Inc. Waggoner Funeral Chapel	Ada	0.0	0.0	0.0	0.0	0.0	0.0
Arrow Planers and Moulding, Inc.	Ada	0.0	0.0	0.0	0.0	0.0	0.0
Gem State Mfg., Inc.	Canyon	0.0	0.0	0.0	5.9	0.0	0.0
Fabrieka International Co.	Ada	0.0	0.2	0.0	1.3	0.1	0.0
Western Idaho Cabinets, Inc.	Ada	0.0	0.0	0.0	0.2	0.0	0.0
GW International	Canyon	0.0	0.1	0.0	0.0	0.1	0.0
YMC Mechanical, Inc.	Ada	0.0	0.0	0.0	0.0	0.0	0.0
Sports Fiberglass, Inc.	Canyon	0.0	0.0	0.0	0.5	0.0	0.0
United Oil	Ada	0.0	0.0	0.0	28.5	0.0	0.0
Sinclair Oil Corp.-Boise Terminal	Ada	0.0	0.0	0.0	28.9	0.0	0.0
Safety Kleen System, Inc.	Ada	0.0	0.0	0.0	0.2	0.0	0.0
Maravia Corporation	Ada	0.0	0.0	0.0	17.2	0.0	0.0
Lynn Research & Technology, Inc.	Ada	0.0	0.0	0.0	1.6	0.0	0.0
Jak's Refinishing Center	Ada	0.0	0.0	0.0	0.7	0.0	0.0
Amoco Oil Company - Boise Terminal	Ada	0.0	0.0	0.0	169.7	0.0	0.0
Total Emissions (tons/year)		1172.6	1795.8	1713.6	1163.6	1984.0	404.6
Total Emissions in Ada County (tons/year)		311.0	302.9	53.5	782.5	160.5	12.7
Total Emissions in Canyon County (tons/year)		861.5	1492.9	1660.1	381.1	1823.4	391.9

Table 2-2a. 1999 point sources episodic PM10 emissions by facility (lbs/day).

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	3,978.7	3,978.7	3,978.7	3,978.7	3,898.4	3,898.4	3,898.4
J.R. Simplot Company - Caldwell	Canyon	1,163.7	1,163.7	1,163.7	428.1	60.3	60.3	60.3
J. R. Simplot Company, Nampa Potato Plant	Canyon	191.9	191.9	191.9	191.9	21.9	21.9	21.9
ConAgra Beef Company	Canyon	118.4	118.4	118.4	118.4	11.4	11.4	11.4
Plum Creek Northwest Lumber, Inc.	Ada	115.0	115.0	115.0	115.0	-	-	-
Chevron Pipeline Boise	Ada	96.1	96.1	96.1	96.1	0.0	0.0	0.0
SSI Food Svc	Canyon	94.2	94.2	94.2	71.2	86.6	5.6	5.6
LP Wood Polymers, Inc.	Ada	83.6	83.6	83.6	83.6	-	-	-
Simplot-Wst.Stock.	Canyon	77.1	77.1	77.1	77.1	27.6	1.2	1.2
Boise Cascade Container	Canyon	76.1	76.1	76.1	50.7	-	-	-
Central Paving PRC	Ada	72.8	72.8	77.9	83.1	-	-	-
Hidden Hollow Landfill	Canyon	71.6	71.6	71.6	71.6	15.7	-	-
Micron Technology	Ada	71.3	71.3	71.3	71.3	46.5	46.5	46.5
Mike's Sand and Gravel	Ada	68.8	68.8	68.8	68.8	-	-	-
Monroc Concrete	Ada	62.5	62.5	62.5	62.5	20.2	-	-
Nelson Const. Co.-Eagle Island	Ada	60.8	60.8	60.8	60.8	18.6	-	-
Builders Masonry Products	Ada	47.1	41.0	41.0	41.0	-	-	-
Monroc-Boise Facility	Ada	43.3	43.3	43.3	43.3	20.7	-	-
Darling International Inc.	Ada	41.6	41.6	41.6	41.6	41.6	-	-
Westfarm Foods-Caldwell	Canyon	36.8	36.9	35.8	38.8	44.2	40.9	43.6
Snake River Chemicals, Inc.	Canyon	36.4	36.4	36.4	36.4	-	-	-
Pacific Press Publishing Association	Canyon	36.4	36.4	36.4	36.5	0.2	0.1	0.1
Canyon Sand and Gravel, Inc.	Canyon	33.1	33.1	33.1	-	-	-	-
Boise Paving PRC	Ada	30.3	30.3	30.3	30.3	-	-	-
Low's Ready Mix, Inc. - Star West Facility	Canyon	27.0	27.0	27.0	27.0	6.7	-	-
Sawtooth Forest Products	Canyon	25.9	25.9	25.9	25.9	-	-	-
Bowman Sand and Gravel	Canyon	21.8	21.8	21.8	21.8	16.2	16.2	16.2
Motivepower, Inc. Apple Street	Ada	21.2	21.2	-	-	-	-	-
Western World, Inc. Circle J Trailers	Canyon	18.1	18.1	18.1	-	-	-	-
Clements Concrete	Ada	17.5	17.5	18.5	17.5	-	-	-
Motivepower, Inc., Branniff Street	Ada	16.7	9.1	-	-	-	-	-
Sorrento Lactalis	Canyon	15.9	15.9	15.9	15.9	2.9	2.9	2.9
IBP	Ada	15.8	16.8	16.6	16.9	7.5	7.4	4.1
Nelson Const. Co.-Diamond	Ada	15.0	15.0	15.0	15.0	2.2	-	-
Consolidated Concrete Company Aspen Road Facility	Ada	13.6	13.6	13.6	13.6	-	-	-
Monroc-Nampa	Canyon	12.0	12.0	12.0	12.0	6.6	-	-
Boise Paving PRC2	Ada	11.0	11.0	11.0	11.0	-	-	-
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	8.1	8.1	8.0	8.1	0.0	0.0	0.0
Turner Sand and Gravel-Boise	Ada	6.9	6.9	8.6	10.3	-	-	-
Can-Ada Crushing	Ada	6.1	6.1	6.1	6.1	3.4	-	-
Western Electronics LLC	Ada	5.8	5.8	5.8	5.8	2.9	0.0	0.0
West Boise WWTF	Ada	5.8	5.8	5.9	5.8	1.3	1.3	1.3

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
Evans Grain, Feeds & Seed Co.	Canyon	4.0	4.0	4.0	4.0	-	-	-
MCMS, Inc.	Canyon	3.4	3.4	3.4	3.4	0.4	0.4	0.4
Simplot AgriSource - Nampa	Canyon	3.2	-	-	-	-	-	-
Castle Wood Products	Ada	3.0	2.3	2.3	-	-	-	-
Idaho Air National Guard	Ada	3.0	3.0	2.6	-	-	-	-
Low's Ready Mix, Eagle	Ada	2.0	12.1	6.0	-	-	-	-
Idaho Truss & Component Company	Ada	1.9	1.4	1.4	1.0	-	-	-
Lander St. WWTF	Ada	1.9	1.9	2.1	1.9	1.8	1.8	1.8
Westfarm Foods-Boise	Ada	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Zilog, Inc.	Canyon	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Zamzow's Feed Mill	Ada	1.4	1.1	1.3	1.5	1.5	-	-
Monroc-Middleton	Canyon	1.3	1.3	1.3	1.3	-	-	-
Zilog Inc.	Canyon	1.2	1.2	1.2	1.2	1.2	1.2	1.2
DblD Feed and Seed	Canyon	0.9	1.4	0.9	1.5	0.3	-	-
Harris Moran Seed Co.	Canyon	0.8	0.8	0.8	0.8	-	-	-
Crookham	Canyon	0.7	0.7	0.7	0.7	0.6	-	-
Atlas Pallet Co.	Canyon	0.7	0.7	0.7	0.7	0.7	-	-
Fiberglass Systems	Ada	0.4	0.4	0.4	0.3	-	-	-
Idaho Asphalt	Canyon	0.3	0.3	0.3	0.9	0.9	0.9	0.9
Hewlett Packard Company	Ada	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Superior Steel Products, Inc.	Canyon	0.3	0.3	0.3	0.3	0.1	-	-
Clayton's Calcium, Inc.	Ada	0.3	0.3	0.3	0.3	0.0	-	-
EPSCO Corp.	Ada	0.2	0.2	0.2	0.2	0.2	-	-
Koch Materials Company	Ada	0.2	0.2	0.2	0.2	-	-	-
Great American Appetizers	Canyon	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Boise Airport	Ada	0.1	-	-	-	-	-	-
Arrow Planers and Moulding, Inc.	Ada	0.1	0.1	0.1	0.0	-	-	-
Gem State Mfg., Inc.	Canyon	0.1	0.1	0.1	0.1	-	-	-
Fabrieka International Co.	Ada	0.1	0.1	0.1	0.1	0.1	-	-
Double D Service Center	Ada	0.1	0.0	0.0	0.1	0.0	-	-
GW International	Canyon	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cloverdale Funeral Home	Ada	0.1	0.1	0.1	0.1	-	-	-
Seminis Veg. Seeds	Canyon	0.1	0.1	0.1	0.0	-	-	-
Riverside Crematory	Ada	0.0	0.1	0.0	0.0	-	-	-
YMC Mechanical, Inc.	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Teton Sales Company	Canyon	0.0	0.0	0.0	0.0	-	-	-
Micronpc.com	Canyon	0.0	0.0	0.0	0.0	1.1	0.0	0.0
Syngenta Seeds, Inc.-Nampa Plant	Canyon	0.0	0.0	0.0	-	-	-	-
Amoco Oil Company - Boise Terminal	Ada	-	-	-	-	-	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	-	-	-	-
Maravia Corporation	Ada	-	-	-	-	-	-	-
Nelson Const. Co.-Amity(777-00208)	Ada	-	8.3	5.2	-	-	-	-
Safety Kleen System, Inc.	Ada	-	-	-	-	-	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	-	-	-	-	-	-	-

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
United Oil	Ada	-	-	-	-	-	-	-
Western Idaho Cabinets, Inc.	Ada	-	-	-	-	-	-	-
Nelson-Deppe Inc. - Canyon	Canyon	-	7.1	7.1	7.1	3.6	-	-
White's Hauling & Farm	Canyon	-	-	-	0.1	0.0	-	-
Total Emissions (lbs/day)		**7,007.1**	**7,015.7**	**6,982.5**	**6,141.1**	**4,379.8**	**4,122.1**	**4,121.5**
Total Emissions in Ada County (lbs/day)		**945.2**	**949.2**	**917.8**	**906.9**	**170.4**	**58.9**	**55.6**
Total Emissions in Canyon County (lbs/day)		**6,061.9**	**6,066.5**	**6,064.8**	**5,234.1**	**4,209.3**	**4,063.2**	**4,065.9**

Table 2-2b. 1999 point sources episodic NOx emissions by facility (lbs/day).

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	12,882.7	12,882.7	12,882.7	12,882.7	12,882.7	12,882.7	12,882.7
J.R. Simplot Company - Caldwell	Canyon	712.0	712.0	712.0	634.7	596.1	596.1	596.1
Motivepower, Inc., Branniff Street	Ada	578.8	7.0	-	-	-	-	-
West Boise WWTF	Ada	223.5	223.5	225.1	223.5	223.5	223.5	223.5
Nelson Const. Co.-Eagle Island	Ada	185.1	185.1	185.1	185.1	185.1	-	-
J. R. Simplot Company, Nampa Potato Plant	Canyon	121.2	121.2	121.2	121.2	121.2	121.2	121.2
Westfarm Foods-Caldwell	Canyon	103.2	102.1	99.3	100.2	99.3	104.2	102.8
ConAgra Beef Company	Canyon	100.6	100.6	100.6	100.6	100.6	100.6	100.6
Central Paving PRC	Ada	95.9	95.9	102.8	109.6	-	-	-
SSI Food Svc	Canyon	92.3	92.3	92.3	89.0	92.3	73.4	73.4
Canyon Sand and Gravel, Inc.	Canyon	89.2	89.2	89.2	-	-	-	-
IBP	Ada	72.1	72.5	72.5	72.6	48.5	47.3	57.6
Nelson Const. Co.-Diamond	Ada	51.8	51.8	51.8	51.8	51.8	-	-
Darling International Inc.	Ada	45.7	45.7	45.7	45.7	45.7	-	-
Boise Paving PRC2	Ada	45.1	45.1	45.1	45.1	-	-	-
Can-Ada Crushing	Ada	43.5	43.5	43.5	43.5	43.5	-	-
Idaho Air National Guard	Ada	35.5	35.5	31.5	-	-	-	-
Chevron Pipeline Boise	Ada	28.4	28.4	28.4	28.4	28.4	28.4	28.4
Lander St. WWTF	Ada	24.3	24.3	27.7	24.3	24.3	24.3	24.3
Zilog, Inc.	Canyon	18.3	18.3	18.3	18.3	18.3	18.3	18.3
Bowman Sand and Gravel	Canyon	17.3	17.3	17.3	17.3	17.3	17.3	17.3
LP Wood Polymers, Inc.	Ada	17.2	17.2	17.2	17.2	-	-	-
Simplot-Wst.Stock.	Canyon	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Zilog Inc.	Canyon	15.6	15.6	15.6	15.6	15.6	15.6	15.6
Sorrento Lactalis	Canyon	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Motivepower, Inc. Apple Street	Ada	11.6	11.6	-	-	-	-	-
Westfarm Foods-Boise	Ada	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Monroc Concrete	Ada	9.6	9.6	9.6	9.6	9.6	-	-
Boise Cascade Container	Canyon	8.9	8.9	8.9	5.9	-	-	-
Pacific Press Publishing Association	Canyon	7.6	7.6	7.6	8.9	4.3	1.8	1.8
MCMS, Inc.	Canyon	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Hidden Hollow Landfill	Canyon	4.9	4.9	4.9	4.9	4.9	-	-
Castle Wood Products	Ada	4.2	3.2	3.2	-	-	-	-
Idaho Asphalt	Canyon	4.1	4.1	4.1	12.2	12.2	12.2	12.2
Hewlett Packard Company	Ada	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Builders Masonry Products	Ada	3.8	3.8	3.8	3.8	-	-	-
Boise Airport	Ada	2.4	-	-	-	-	-	-
Fabrieka International Co.	Ada	2.0	2.0	2.0	2.0	2.0	-	-
Great American Appetizers	Canyon	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Monroc-Boise Facility	Ada	1.2	1.2	1.2	1.2	1.2	-	-
GW International	Canyon	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Western Electronics LLC	Ada	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
Zamzow's Feed Mill	Ada	0.5	0.5	0.5	0.6	0.5	-	-
Cloverdale Funeral Home	Ada	0.5	0.7	0.5	0.8	-	-	-
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	0.5	0.5	0.4	0.5	0.5	0.3	0.3
Riverside Crematory	Ada	0.3	0.7	0.3	0.3	-	-	-
Snake River Chemicals, Inc.	Canyon	0.3	0.3	0.3	0.3	-	-	-
DblD Feed and Seed	Canyon	0.3	0.3	0.2	0.2	0.1	-	-
Micronpc.com	Canyon	0.2	0.2	0.2	0.2	19.9	0.2	0.2
EPSCO Corp.	Ada	0.1	0.1	0.1	0.1	0.1	-	-
Amoco Oil Company - Boise Terminal	Ada	-	-	-	-	-	-	-
Arrow Planers and Moulding, Inc.	Ada	-	-	-	-	-	-	-
Boise Paving PRC	Ada	-	-	-	-	-	-	-
Clayton's Calcium, Inc.	Ada	-	-	-	-	-	-	-
Clements Concrete	Ada	-	-	-	-	-	-	-
Consolidated Concrete Company Aspen Road Facility	Ada	-	-	-	-	-	-	-
Double D Service Center	Ada	-	-	-	-	-	-	-
Fiberglass Systems	Ada	-	-	-	-	-	-	-
Idaho Truss & Component Company	Ada	-	-	-	-	-	-	-
Koch Materials Company	Ada	-	-	-	-	-	-	-
Low's Ready Mix, Eagle	Ada	-	-	-	-	-	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	-	-	-	-
Maravia Corporation	Ada	-	-	-	-	-	-	-
Micron Technology	Ada	-	-	-	-	-	-	-
Mike's Sand and Gravel	Ada	-	-	-	-	-	-	-
Nelson Const. Co.-Amity(777-00208)	Ada	-	14.3	9.1	-	-	-	-
Plum Creek Northwest Lumber, Inc.	Ada	-	-	-	-	-	-	-
Safety Kleen System, Inc.	Ada	-	-	-	-	-	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	-	-	-	-	-	-	-
Turner Sand and Gravel-Boise	Ada	-	-	-	-	-	-	-
United Oil	Ada	-	-	-	-	-	-	-
Western Idaho Cabinets, Inc.	Ada	-	-	-	-	-	-	-
YMC Mechanical, Inc.	Ada	-	-	-	-	-	-	-
Atlas Pallet Co.	Canyon	-	-	-	-	-	-	-
Crookham	Canyon	-	-	-	-	-	-	-
Evans Grain, Feeds & Seed Co.	Canyon	-	-	-	-	-	-	-
Gem State Mfg., Inc.	Canyon	-	-	-	-	-	-	-
Harris Moran Seed Co.	Canyon	-	-	-	-	-	-	-
Low's Ready Mix, Inc. - Star West Facility	Canyon	-	-	-	-	-	-	-
Monroc-Middleton	Canyon	-	-	-	-	-	-	-
Monroc-Nampa	Canyon	-	-	-	-	-	-	-
Nelson-Deppe Inc. - Canyon	Canyon	-	49.3	49.3	49.3	49.3	-	-
Sawtooth Forest Products	Canyon	-	-	-	-	-	-	-
Seminis Veg. Seeds	Canyon	-	-	-	-	-	-	-
Simplot AgriSource - Nampa	Canyon	-	-	-	-	-	-	-
Superior Steel Products, Inc.	Canyon	-	-	-	-	-	-	-

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
Syngenta Seeds, Inc.-Nampa Plant	Canyon	-	-	-	-	-	-	-
Teton Sales Company	Canyon	-	-	-	-	-	-	-
Western World, Inc. Circle J Trailers	Canyon	-	-	-	-	-	-	-
White's Hauling & Farm	Canyon	-	-	-	-	-	-	-
Total Emissions (lbs/day)		**15,716.7**	**15,204.8**	**15,185.3**	**14,981.5**	**14,753.1**	**14,321.7**	**14,330.6**
Total Emissions in Ada County (lbs/day)		**1,497.6**	**937.5**	**921.0**	**879.6**	**678.5**	**337.8**	**348.0**
Total Emissions in Canyon County (lbs/day)		**14,219.1**	**14,267.2**	**14,264.3**	**14,101.9**	**14,074.6**	**13,983.9**	**13,982.5**

Table 2-2c. 1999 point sources episodic SOx emissions by facility (lbs/day).

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	19,419.8	19,419.8	19,419.8	19,419.8	19,419.8	19,419.8	19,419.8
J.R. Simplot Company - Caldwell	Canyon	505.3	505.3	505.3	504.9	504.6	504.6	504.6
Motivepower, Inc., Branniff Street	Ada	38.7	0.3	-	-	-	-	-
Nelson Const. Co.-Eagle Island	Ada	29.2	29.2	29.2	29.2	29.2	-	-
Lander St. WWTF	Ada	21.9	21.9	22.1	21.9	21.9	21.9	21.9
West Boise WWTF	Ada	17.1	17.1	17.2	17.1	17.1	17.1	17.1
Canyon Sand and Gravel, Inc.	Canyon	14.5	14.5	14.5	-	-	-	-
Nelson Const. Co.-Diamond	Ada	8.2	8.2	8.2	8.2	8.2	-	-
Can-Ada Crushing	Ada	6.8	6.8	6.8	6.8	6.8	-	-
Central Paving PRC	Ada	6.3	6.3	6.8	7.2	-	-	-
Monroc-Boise Facility	Ada	4.4	4.4	4.4	4.4	4.4	-	-
Boise Paving PRC2	Ada	3.0	3.0	3.0	3.0	-	-	-
Darling International Inc.	Ada	2.8	2.8	2.8	2.8	2.8	-	-
Westfarm Foods-Boise	Ada	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	1.3	1.3	1.1	1.3	1.3	0.7	0.7
Bowman Sand and Gravel	Canyon	1.1	1.1	1.1	1.1	1.1	1.1	1.1
IBP	Ada	0.9	0.9	0.9	0.9	0.4	0.3	0.3
J. R. Simplot Company, Nampa Potato Plant	Canyon	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Westfarm Foods-Caldwell	Canyon	0.6	0.6	0.6	0.6	0.6	0.6	0.6
ConAgra Beef Company	Canyon	0.6	0.6	0.6	0.6	0.6	0.6	0.6
SSI Food Svc	Canyon	0.6	0.6	0.6	0.5	0.6	0.4	0.4
Idaho Air National Guard	Ada	0.4	0.4	0.3	-	-	-	-
Hidden Hollow Landfill	Canyon	0.3	0.3	0.3	0.3	0.3	-	-
Castle Wood Products	Ada	0.3	0.2	0.2	-	-	-	-
Sorrento Lactalis	Canyon	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Boise Cascade Container	Canyon	0.2	0.2	0.2	0.1	-	-	-
Hewlett Packard Company	Ada	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Zilog, Inc.	Canyon	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Boise Airport	Ada	0.1	-	-	-	-	-	-
Simplot-Wst.Stock.	Canyon	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Zilog Inc.	Canyon	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Motivepower, Inc. Apple Street	Ada	0.1	0.1	-	-	-	-	-
Cloverdale Funeral Home	Ada	0.1	0.1	0.1	0.1	-	-	-
Monroc Concrete	Ada	0.1	0.1	0.1	0.1	0.1	-	-
DblD Feed and Seed	Canyon	0.0	0.0	0.0	0.0	0.0	-	-
Riverside Crematory	Ada	0.0	0.1	0.0	0.0	-	-	-
MCMS, Inc.	Canyon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Press Publishing Association	Canyon	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Idaho Asphalt	Canyon	0.0	0.0	0.0	0.1	0.1	0.1	0.1
Builders Masonry Products	Ada	0.0	0.0	0.0	0.0	-	-	-
Fabrieka International Co.	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Great American Appetizers	Canyon	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
GW International	Canyon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zamzow's Feed Mill	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Western Electronics LLC	Ada	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snake River Chemicals, Inc.	Canyon	0.0	0.0	0.0	0.0	-	-	-
Chevron Pipeline Boise	Ada	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EPSCO Corp.	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Micronpc.com	Canyon	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Amoco Oil Company - Boise Terminal	Ada	-	-	-	-	-	-	-
Arrow Planers and Moulding, Inc.	Ada	-	-	-	-	-	-	-
Boise Paving PRC	Ada	-	-	-	-	-	-	-
Clayton's Calcium, Inc.	Ada	-	-	-	-	-	-	-
Clements Concrete	Ada	-	-	-	-	-	-	-
Consolidated Concrete Company Aspen Road Facility	Ada	-	-	-	-	-	-	-
Double D Service Center	Ada	-	-	-	-	-	-	-
Fiberglass Systems	Ada	-	-	-	-	-	-	-
Idaho Truss & Component Company	Ada	-	-	-	-	-	-	-
Koch Materials Company	Ada	-	-	-	-	-	-	-
Low's Ready Mix, Eagle	Ada	-	-	-	-	-	-	-
LP Wood Polymers, Inc.	Ada	-	-	-	-	-	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	-	-	-	-
Maravia Corporation	Ada	-	-	-	-	-	-	-
Micron Technology	Ada	-	-	-	-	-	-	-
Mike's Sand and Gravel	Ada	-	-	-	-	-	-	-
Nelson Const. Co.-Amity(777-00208)	Ada	-	0.5	0.3	-	-	-	-
Plum Creek Northwest Lumber, Inc.	Ada	-	-	-	-	-	-	-
Safety Kleen System, Inc.	Ada	-	-	-	-	-	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	-	-	-	-	-	-	-
Turner Sand and Gravel-Boise	Ada	-	-	-	-	-	-	-
United Oil	Ada	-	-	-	-	-	-	-
Western Idaho Cabinets, Inc.	Ada	-	-	-	-	-	-	-
YMC Mechanical, Inc.	Ada	-	-	-	-	-	-	-
Atlas Pallet Co.	Canyon	-	-	-	-	-	-	-
Crookham	Canyon	-	-	-	-	-	-	-
Evans Grain, Feeds & Seed Co.	Canyon	-	-	-	-	-	-	-
Gem State Mfg., Inc.	Canyon	-	-	-	-	-	-	-
Harris Moran Seed Co.	Canyon	-	-	-	-	-	-	-
Low's Ready Mix, Inc. - Star West Facility	Canyon	-	-	-	-	-	-	-
Monroc-Middleton	Canyon	-	-	-	-	-	-	-
Monroc-Nampa	Canyon	-	-	-	-	-	-	-
Nelson-Deppe Inc. - Canyon	Canyon	-	3.2	3.2	3.2	3.2	-	-
Sawtooth Forest Products	Canyon	-	-	-	-	-	-	-
Seminis Veg. Seeds	Canyon	-	-	-	-	-	-	-
Simplot AgriSource - Nampa	Canyon	-	-	-	-	-	-	-
Superior Steel Products, Inc.	Canyon	-	-	-	-	-	-	-

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
Syngenta Seeds, Inc.-Nampa Plant	Canyon	-	-	-	-	-	-	-
Teton Sales Company	Canyon	-	-	-	-	-	-	-
Western World, Inc. Circle J Trailers	Canyon	-	-	-	-	-	-	-
White's Hauling & Farm	Canyon	-	-	-	-	-	-	-
Total Emissions (lbs/day)		**20,088.8**	**20,054.1**	**20,054.0**	**20,038.6**	**20,028.3**	**19,971.5**	**19,971.6**
Total Emissions in Ada County (lbs/day)		**143.0**	**105.1**	**105.2**	**104.6**	**93.6**	**42.1**	**42.2**
Total Emissions in Canyon County (lbs/day)		**19,945.8**	**19,949.0**	**19,948.8**	**19,934.1**	**19,934.6**	**19,929.4**	**19,929.4**

Table 2-2d. 1999 point sources episodic VOC emissions by facility (lbs/day).

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
Chevron Pipeline Boise	Ada	1,196.5	1,196.5	1,196.5	1,196.5	1,196.5	1,196.5	1,196.5
Amoco Oil Company - Boise Terminal	Ada	942.7	942.7	942.7	942.7	942.7	942.7	942.7
Micron Technology	Ada	536.5	536.5	536.5	536.5	536.5	536.5	536.5
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	388.5	388.5	388.5	388.5	388.5	388.5	388.5
Motivepower, Inc. Apple Street	Ada	287.1	287.1	-	-	-	-	-
J. R. Simplot Company, Nampa Potato Plant	Canyon	255.4	255.4	255.4	255.4	179.8	179.8	179.8
J.R. Simplot Company - Caldwell	Canyon	239.1	239.1	239.1	187.2	161.2	161.2	74.3
Western World, Inc. Circle J Trailers	Canyon	201.1	201.1	201.1	-	-	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	159.8	159.8	159.8	159.8	159.8	159.8	159.8
United Oil	Ada	156.6	156.6	156.6	156.6	156.6	156.6	156.6
Pacific Press Publishing Association	Canyon	108.0	108.0	108.0	108.0	0.2	0.1	0.1
Hidden Hollow Landfill	Canyon	74.4	74.4	74.4	74.4	74.4	-	-
Motivepower, Inc., Branniff Street	Ada	33.7	18.4	-	-	-	-	-
Boise Cascade Container	Canyon	20.7	20.7	20.7	13.8	-	-	-
LP Wood Polymers, Inc.	Ada	16.1	16.1	16.1	16.1	-	-	-
Darling International Inc.	Ada	15.7	15.7	15.7	15.7	15.7	-	-
IBP	Ada	12.1	12.1	12.1	12.1	5.9	5.8	4.3
Idaho Asphalt	Canyon	10.3	10.3	10.3	10.8	12.0	12.0	12.0
West Boise WWTF	Ada	8.4	8.4	8.5	8.4	8.4	8.4	8.4
Westfarm Foods-Caldwell	Canyon	5.6	5.6	5.4	5.5	5.4	5.7	5.6
ConAgra Beef Company	Canyon	5.5	5.5	5.5	5.5	5.5	5.5	5.5
SSI Food Svc	Canyon	5.1	5.1	5.1	4.9	5.1	4.0	4.0
Nelson Const. Co.-Eagle Island	Ada	4.7	4.7	4.7	4.7	4.7	-	-
Idaho Air National Guard	Ada	4.6	4.6	4.1	-	-	-	-
Canyon Sand and Gravel, Inc.	Canyon	2.6	2.6	2.6	-	-	-	-
Sorrento Lactalis	Canyon	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Safety Kleen System, Inc.	Ada	1.7	1.7	1.7	1.7	-	-	-
Western Idaho Cabinets, Inc.	Ada	1.4	1.4	0.6	-	-	-	-
Fabrieka International Co.	Ada	1.3	1.3	1.3	1.3	1.3	-	-
Nelson Const. Co.-Diamond	Ada	1.3	1.3	1.3	1.3	1.3	-	-
Westfarm Foods-Boise	Ada	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Zilog, Inc.	Canyon	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lander St. WWTF	Ada	0.9	0.9	1.2	0.9	0.9	0.9	0.9
Simplot-Wst.Stock.	Canyon	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Zilog Inc.	Canyon	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Monroc Concrete	Ada	0.5	0.5	0.5	0.5	0.5	-	-
Castle Wood Products	Ada	0.3	0.3	0.3	-	-	-	-
MCMS, Inc.	Canyon	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Builders Masonry Products	Ada	0.2	0.2	0.2	0.2	-	-	-
Hewlett Packard Company	Ada	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Great American Appetizers	Canyon	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Western Electronics LLC	Ada	0.1	0.1	0.1	0.1	0.1	0.0	0.0

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
Can-Ada Crushing	Ada	0.1	0.1	0.1	0.1	0.1	-	-
Boise Airport	Ada	0.1	-	-	-	-	-	-
GW International	Canyon	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Zamzow's Feed Mill	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Monroc-Boise Facility	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Snake River Chemicals, Inc.	Canyon	0.0	0.0	0.0	0.0	-	-	-
Cloverdale Funeral Home	Ada	0.0	0.0	0.0	0.0	-	-	-
EPSCO Corp.	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Riverside Crematory	Ada	0.0	0.0	0.0	0.0	-	-	-
Micronpc.com	Canyon	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Arrow Planers and Moulding, Inc.	Ada	-	-	-	-	-	-	-
Boise Paving PRC	Ada	-	-	-	-	-	-	-
Boise Paving PRC2	Ada	-	-	-	-	-	-	-
Central Paving PRC	Ada	-	-	-	-	-	-	-
Clayton's Calcium, Inc.	Ada	-	-	-	-	-	-	-
Clements Concrete	Ada	-	-	-	-	-	-	-
Consolidated Concrete Company Aspen Road Facility	Ada	-	-	-	-	-	-	-
Double D Service Center	Ada	-	-	-	-	-	-	-
Fiberglass Systems	Ada	-	-	-	-	-	-	-
Idaho Truss & Component Company	Ada	-	-	-	-	-	-	-
Koch Materials Company	Ada	-	-	-	-	-	-	-
Low's Ready Mix, Eagle	Ada	-	-	-	-	-	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	-	-	-	-
Maravia Corporation	Ada	-	-	-	-	-	-	-
Mike's Sand and Gravel	Ada	-	-	-	-	-	-	-
Nelson Const. Co.-Amity(777-00208)	Ada	-	7.6	4.8	-	-	-	-
Plum Creek Northwest Lumber, Inc.	Ada	-	-	-	-	-	-	-
Turner Sand and Gravel-Boise	Ada	-	-	-	-	-	-	-
YMC Mechanical, Inc.	Ada	-	-	-	-	-	-	-
Atlas Pallet Co.	Canyon	-	-	-	-	-	-	-
Bowman Sand and Gravel	Canyon	-	-	-	-	-	-	-
Crookham	Canyon	-	-	-	-	-	-	-
DblD Feed and Seed	Canyon	-	-	-	-	-	-	-
Evans Grain, Feeds & Seed Co.	Canyon	-	-	-	-	-	-	-
Gem State Mfg., Inc.	Canyon	-	-	-	-	-	-	-
Harris Moran Seed Co.	Canyon	-	-	-	-	-	-	-
Low's Ready Mix, Inc. - Star West Facility	Canyon	-	-	-	-	-	-	-
Monroc-Middleton	Canyon	-	-	-	-	-	-	-
Monroc-Nampa	Canyon	-	-	-	-	-	-	-
Nelson-Deppe Inc. - Canyon	Canyon	-	-	-	-	-	-	-
Sawtooth Forest Products	Canyon	-	-	-	-	-	-	-
Seminis Veg. Seeds	Canyon	-	-	-	-	-	-	-
Simplot AgriSource - Nampa	Canyon	-	-	-	-	-	-	-
Superior Steel Products, Inc.	Canyon	-	-	-	-	-	-	-

Facility Name	**County**	**20-Dec**	**21-Dec**	**22-Dec**	**23-Dec**	**24-Dec**	**25-Dec**	**26-Dec**
Syngenta Seeds, Inc.-Nampa Plant	Canyon	-	-	-	-	-	-	-
Teton Sales Company	Canyon	-	-	-	-	-	-	-
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	-	-	-	-	-	-	-
White's Hauling & Farm	Canyon	-	-	-	-	-	-	-
Total Emissions (lbs/day)		**4,705.8**	**4,697.8**	**4,388.5**	**4,116.1**	**3,870.1**	**3,770.6**	**3,682.1**
Total Emissions in Ada County (lbs/day)		**3,384.0**	**3,376.1**	**3,066.9**	**3,056.8**	**3,032.4**	**3,008.5**	**3,007.0**
Total Emissions in Canyon County (lbs/day)		**1,321.8**	**1,321.7**	**1,321.6**	**1,059.4**	**837.7**	**762.1**	**675.1**

Table 2-2e. 1999 point sources episodic CO emissions by facility (lbs/day).

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	31,960.0	31,960.0	31,960.0	31,960.0	31,960.0	31,960.0	31,960.0
J.R. Simplot Company - Caldwell	Canyon	764.0	764.0	764.0	699.2	666.7	666.7	666.7
Motivepower, Inc., Branniff Street	Ada	133.1	3.1	-	-	-	-	-
J. R. Simplot Company, Nampa Potato Plant	Canyon	94.8	94.8	94.8	94.8	94.8	94.8	94.8
ConAgra Beef Company	Canyon	84.5	84.5	84.5	84.5	84.5	84.5	84.5
SSI Food Svc	Canyon	77.5	77.5	77.5	74.7	77.5	61.7	61.7
Chevron Pipeline Boise	Ada	75.9	75.9	75.9	75.9	75.9	75.9	75.9
Westfarm Foods-Caldwell	Canyon	70.7	70.4	69.9	70.1	69.9	70.9	70.6
IBP	Ada	59.7	59.7	59.7	59.7	40.0	39.8	48.4
Nelson Const. Co.-Eagle Island	Ada	49.2	49.2	49.2	49.2	49.2	-	-
Darling International Inc.	Ada	43.5	43.5	43.5	43.5	43.5	-	-
West Boise WWTF	Ada	34.3	34.3	34.7	34.3	34.3	34.3	34.3
Sorrento Lactalis	Canyon	32.1	32.1	32.1	32.1	32.1	32.1	32.1
Canyon Sand and Gravel, Inc.	Canyon	24.4	24.4	24.4	-	-	-	-
Boise Cascade Container	Canyon	23.2	23.2	23.2	15.5	-	-	-
Idaho Air National Guard	Ada	22.2	22.2	19.8	-	-	-	-
Hidden Hollow Landfill	Canyon	20.7	20.7	20.7	20.7	20.7	-	-
Central Paving PRC	Ada	20.6	20.6	22.1	23.6	-	-	-
Lander St. WWTF	Ada	20.4	20.4	21.1	20.4	20.4	20.4	20.4
Westfarm Foods-Boise	Ada	16.4	16.4	16.4	16.4	16.4	16.4	16.4
Zilog, Inc.	Canyon	15.4	15.4	15.4	15.4	15.4	15.4	15.4
Nelson Const. Co.-Diamond	Ada	13.8	13.8	13.8	13.8	13.8	-	-
Simplot-Wst.Stock.	Canyon	13.3	13.3	13.3	13.3	13.3	13.3	13.3
Zilog Inc.	Canyon	13.1	13.1	13.1	13.1	13.1	13.1	13.1
Can-Ada Crushing	Ada	11.5	11.5	11.5	11.5	11.5	-	-
Motivepower, Inc. Apple Street	Ada	9.8	9.8	-	-	-	-	-
Boise Paving PRC2	Ada	9.7	9.7	9.7	9.7	-	-	-
Monroc Concrete	Ada	8.1	8.1	8.1	8.1	8.1	-	-
LP Wood Polymers, Inc.	Ada	6.7	6.7	6.7	6.7	-	-	-
MCMS, Inc.	Canyon	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Bowman Sand and Gravel	Canyon	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Idaho Asphalt	Canyon	3.5	3.5	3.5	10.2	10.2	10.2	10.2
Hewlett Packard Company	Ada	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Builders Masonry Products	Ada	3.2	3.2	3.2	3.2	-	-	-
Pacific Press Publishing Association	Canyon	1.9	1.9	1.9	2.2	1.7	1.2	1.2
Great American Appetizers	Canyon	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Fabrieka International Co.	Ada	1.1	1.1	1.1	1.1	1.1	-	-
Castle Wood Products	Ada	0.9	0.7	0.7	-	-	-	-
GW International	Canyon	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Boise Airport	Ada	0.5	-	-	-	-	-	-
Zamzow's Feed Mill	Ada	0.4	0.4	0.4	0.5	0.4	-	-
Monroc-Boise Facility	Ada	0.3	0.3	0.3	0.3	0.3	-	-
Western Electronics LLC	Ada	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Micronpc.com	Canyon	0.1	0.1	0.1	0.1	4.0	0.1	0.1
Snake River Chemicals, Inc.	Canyon	0.1	0.1	0.1	0.1	-	-	-
DblD Feed and Seed	Canyon	0.1	0.1	0.0	0.0	0.0	-	-

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
EPSCO Corp.	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Cloverdale Funeral Home	Ada	0.0	0.0	0.0	0.0	-	-	-
Riverside Crematory	Ada	0.0	0.0	0.0	0.0	-	-	-
Amoco Oil Company - Boise Terminal	Ada	-	-	-	-	-	-	-
Arrow Planers and Moulding, Inc.	Ada	-	-	-	-	-	-	-
Boise Paving PRC	Ada	-	-	-	-	-	-	-
Clayton's Calcium, Inc.	Ada	-	-	-	-	-	-	-
Clements Concrete	Ada	-	-	-	-	-	-	-
Consolidated Concrete Company Aspen Road Facility	Ada	-	-	-	-	-	-	-
Double D Service Center	Ada	-	-	-	-	-	-	-
Fiberglass Systems	Ada	-	-	-	-	-	-	-
Idaho Truss & Component Company	Ada	-	-	-	-	-	-	-
Koch Materials Company	Ada	-	-	-	-	-	-	-
Low's Ready Mix, Eagle	Ada	-	-	-	-	-	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	-	-	-	-
Maravia Corporation	Ada	-	-	-	-	-	-	-
Micron Technology	Ada	-	-	-	-	-	-	-
Mike's Sand and Gravel	Ada	-	-	-	-	-	-	-
Nelson Const. Co.-Amity(777-00208)	Ada	-	22.9	14.5	-	-	-	-
Plum Creek Northwest Lumber, Inc.	Ada	-	-	-	-	-	-	-
Safety Kleen System, Inc.	Ada	-	-	-	-	-	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	-	-	-	-	-	-	-
Turner Sand and Gravel-Boise	Ada	-	-	-	-	-	-	-
United Oil	Ada	-	-	-	-	-	-	-
Western Idaho Cabinets, Inc.	Ada	-	-	-	-	-	-	-
YMC Mechanical, Inc.	Ada	-	-	-	-	-	-	-
Atlas Pallet Co.	Canyon	-	-	-	-	-	-	-
Crookham	Canyon	-	-	-	-	-	-	-
Evans Grain, Feeds & Seed Co.	Canyon	-	-	-	-	-	-	-
Gem State Mfg., Inc.	Canyon	-	-	-	-	-	-	-
Harris Moran Seed Co.	Canyon	-	-	-	-	-	-	-
Low's Ready Mix, Inc. - Star West Facility	Canyon	-	-	-	-	-	-	-
Monroc-Middleton	Canyon	-	-	-	-	-	-	-
Monroc-Nampa	Canyon	-	-	-	-	-	-	-
Nelson-Deppe Inc. - Canyon	Canyon	-	10.6	10.6	10.6	10.6	-	-
Sawtooth Forest Products	Canyon	-	-	-	-	-	-	-
Seminis Veg. Seeds	Canyon	-	-	-	-	-	-	-
Simplot AgriSource - Nampa	Canyon	-	-	-	-	-	-	-
Superior Steel Products, Inc.	Canyon	-	-	-	-	-	-	-
Syngenta Seeds, Inc.-Nampa Plant	Canyon	-	-	-	-	-	-	-
Teton Sales Company	Canyon	-	-	-	-	-	-	-
Western World, Inc. Circle J Trailers	Canyon	-	-	-	-	-	-	-
White's Hauling & Farm	Canyon	-	-	-	-	-	-	-
Total Emissions (lbs/day)		**33,755.2**	**33,657.7**	**33,635.9**	**33,508.8**	**33,403.9**	**33,225.0**	**33,233.4**
Total Emissions in Ada County (lbs/day)		**544.8**	**437.0**	**415.8**	**381.3**	**318.3**	**190.2**	**198.8**
Total Emissions in Canyon County (lbs/day)		**33,210.4**	**33,220.7**	**33,220.1**	**33,127.5**	**33,085.6**	**33,034.9**	**33,034.6**

Table 2-2f. 1999 point sources episodic NH3 emissions by facility (lbs/day).

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	3,411.5	3,411.5	3,411.5	3,411.5	3,411.5	3,411.5	3,411.5
Micron Technology	Ada	56.5	56.5	56.5	56.5	56.5	56.5	56.5
Westfarm Foods-Caldwell	Canyon	23.5	23.5	23.5	23.5	23.5	23.5	23.5
Zilog, Inc.	Canyon	16.7	16.7	16.7	16.7	4.2	0.1	0.1
ConAgra Beef Company	Canyon	12.1	12.1	12.1	12.1	12.1	12.1	3.5
West Boise WWTF	Ada	9.0	9.0	9.0	9.0	9.0	1.3	1.3
Darling International Inc.	Ada	3.8	3.8	3.8	3.8	3.8	-	-
Zilog Inc.	Canyon	3.1	3.1	3.1	3.1	0.8	0.1	0.1
SSI Food Svc	Canyon	3.0	3.0	3.0	2.8	3.0	2.3	2.3
J. R. Simplot Company, Nampa Potato Plant	Canyon	2.9	2.9	2.9	2.9	2.9	2.9	2.9
IBP	Ada	1.8	1.8	1.8	1.8	1.1	1.1	1.8
Lander St. WWTF	Ada	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Boise Cascade Container	Canyon	0.9	0.9	0.9	0.6	-	-	-
Westfarm Foods-Boise	Ada	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Sorrento Lactalis	Canyon	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MCMS, Inc.	Canyon	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Idaho Asphalt	Canyon	0.1	0.1	0.1	0.4	0.4	0.4	0.4
Hewlett Packard Company	Ada	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Builders Masonry Products	Ada	0.1	0.1	0.1	0.1	-	-	-
Motivepower, Inc., Branniff Street	Ada	0.1	0.1	-	-	-	-	-
Great American Appetizers	Canyon	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Monroc Concrete	Ada	0.0	0.0	0.0	0.0	0.0	-	-
GW International	Canyon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zamzow's Feed Mill	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Idaho Air National Guard	Ada	0.0	0.0	0.0	-	-	-	-
DblD Feed and Seed	Canyon	0.0	0.0	0.0	0.0	0.0	-	-
Pacific Press Publishing Association	Canyon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	0.0	0.0	0.0	0.0	0.0	-	-
Fabrieka International Co.	Ada	0.0	0.0	0.0	0.0	0.0	-	-
Micronpc.com	Canyon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boise Airport	Ada	0.0	-	-	-	-	-	-
Amoco Oil Company - Boise Terminal	Ada	-	-	-	-	-	-	-
Arrow Planers and Moulding, Inc.	Ada	-	-	-	-	-	-	-
Boise Paving PRC	Ada	-	-	-	-	-	-	-
Boise Paving PRC2	Ada	-	-	-	-	-	-	-
Can-Ada Crushing	Ada	-	-	-	-	-	-	-
Castle Wood Products	Ada	-	-	-	-	-	-	-
Central Paving PRC	Ada	-	-	-	-	-	-	-
Chevron Pipeline Boise	Ada	-	-	-	-	-	-	-
Clayton's Calcium, Inc.	Ada	-	-	-	-	-	-	-
Clements Concrete	Ada	-	-	-	-	-	-	-
Cloverdale Funeral Home	Ada	-	-	-	-	-	-	-
Consolidated Concrete Company Aspen Road Facility	Ada	-	-	-	-	-	-	-

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
Double D Service Center	Ada	-	-	-	-	-	-	-
EPSCO Corp.	Ada	-	-	-	-	-	-	-
Fiberglass Systems	Ada	-	-	-	-	-	-	-
Idaho Truss & Component Company	Ada	-	-	-	-	-	-	-
Koch Materials Company	Ada	-	-	-	-	-	-	-
Low's Ready Mix, Eagle	Ada	-	-	-	-	-	-	-
LP Wood Polymers, Inc.	Ada	-	-	-	-	-	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	-	-	-	-
Maravia Corporation	Ada	-	-	-	-	-	-	-
Mike's Sand and Gravel	Ada	-	-	-	-	-	-	-
Monroc-Boise Facility	Ada	-	-	-	-	-	-	-
Motivepower, Inc. Apple Street	Ada	-	-	-	-	-	-	-
Nelson Const. Co.-Amity(777-00208)	Ada	-	-	-	-	-	-	-
Nelson Const. Co.-Diamond	Ada	-	-	-	-	-	-	-
Nelson Const. Co.-Eagle Island	Ada	-	-	-	-	-	-	-
Plum Creek Northwest Lumber, Inc.	Ada	-	-	-	-	-	-	-
Riverside Crematory	Ada	-	-	-	-	-	-	-
Safety Kleen System, Inc.	Ada	-	-	-	-	-	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	-	-	-	-	-	-	-
Turner Sand and Gravel-Boise	Ada	-	-	-	-	-	-	-
United Oil	Ada	-	-	-	-	-	-	-
Western Electronics LLC	Ada	-	-	-	-	-	-	-
Western Idaho Cabinets, Inc.	Ada	-	-	-	-	-	-	-
YMC Mechanical, Inc.	Ada	-	-	-	-	-	-	-
Atlas Pallet Co.	Canyon	-	-	-	-	-	-	-
Bowman Sand and Gravel	Canyon	-	-	-	-	-	-	-
Canyon Sand and Gravel, Inc.	Canyon	-	-	-	-	-	-	-
Crookham	Canyon	-	-	-	-	-	-	-
Evans Grain, Feeds & Seed Co.	Canyon	-	-	-	-	-	-	-
Gem State Mfg., Inc.	Canyon	-	-	-	-	-	-	-
Harris Moran Seed Co.	Canyon	-	-	-	-	-	-	-
Hidden Hollow Landfill	Canyon	-	-	-	-	-	-	-
J.R. Simplot Company - Caldwell	Canyon	-	-	-	-	-	-	-
Low's Ready Mix, Inc. - Star West Facility	Canyon	-	-	-	-	-	-	-
Monroc-Middleton	Canyon	-	-	-	-	-	-	-
Monroc-Nampa	Canyon	-	-	-	-	-	-	-
Nelson-Deppe Inc. - Canyon	Canyon	-	-	-	-	-	-	-
Sawtooth Forest Products	Canyon	-	-	-	-	-	-	-
Seminis Veg. Seeds	Canyon	-	-	-	-	-	-	-
Simplot AgriSource - Nampa	Canyon	-	-	-	-	-	-	-
Simplot-Wst.Stock.	Canyon	-	-	-	-	-	-	-
Snake River Chemicals, Inc.	Canyon	-	-	-	-	-	-	-
Superior Steel Products, Inc.	Canyon	-	-	-	-	-	-	-
Syngenta Seeds, Inc.-Nampa Plant	Canyon	-	-	-	-	-	-	-
Teton Sales Company	Canyon	-	-	-	-	-	-	-
Western World, Inc. Circle J Trailers	Canyon	-	-	-	-	-	-	-

Facility Name	County	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec
White's Hauling & Farm	Canyon	-	-	-	-	-	-	-
Total Emissions (lbs/day)		**3,547.6**	**3,547.6**	**3,547.5**	**3,547.3**	**3,531.3**	**3,514.2**	**3,506.4**
Total Emissions in Ada County (lbs/day)		**73.3**	**73.3**	**73.2**	**73.2**	**72.4**	**60.8**	**61.6**
Total Emissions in Canyon County (lbs/day)		**3,474.3**	**3,474.3**	**3,474.2**	**3,474.1**	**3,458.9**	**3,453.4**	**3,444.8**

3.0 1999 AREA SOURCES

Area sources are defined as all stationary sources (both anthropogenic and nonanthropogenic) which are not included in the industrial point source inventory. As explained in Section 2.0, sources with annual PM_{10} emissions greater than five tons per year (tpy) from a single point were defined as major industrial point sources. In addition, sources with less than five tpy that responded to the point source questionnaire survey (described in Section 2.1.1) were included in the industrial point source inventory. All other stationary sources were included in the area source inventory. Although re-entrained road dust from paved and unpaved roads are often considered to be area sources, for the 1999 Ada and Canyon County emissions inventory, these two categories were included with the on-road mobile sources because of their direct relationship with vehicle miles traveled (VMT) (see Section 4.0). Off-road mobile sources were also treated separately (see Section 5.0). The steps taken to ensure that no "double counting" of emissions occurred between point source and area source emissions are described in Section 3.2.11.

The area source inventory will include PM_{10}, NO_x, SO_x, NH_3, VOC, and CO emissions for the 1999 base year. Average annual and episodic daily emissions (i.e., weekday and weekend day) were developed for each of the source categories listed in Table 3-1. Table 3-1 provides the following information for each area source category:

- Pollutants of concern;
- Source of methodology and/or emission factors;
- Type of activity data;
- Source of activity data; and
- Comments.

Details regarding the area sources data collection, emission estimation methodology, and QA/QC procedures are discussed in the remainder of this section.

3.1 DATA COLLECTION PROCEDURES AND RESULTS

As described in Section 2.1.1, the industrial point source inventory relied heavily on the point source questionnaire (PSQ) survey. The area source inventory, however, did not rely exclusively upon one type of data collection. The only formal survey that was conducted was a fuel survey which is described below.

3.1.1 Fuel Survey

The fuel survey methodology used was similar to the one used in the previous 1995 inventory (SAI, 1997). A sample fuel survey form is provided in Appendix B-1. However, a more comprehensive list of 84 potential fuel suppliers and dealers was developed for the 1999 emissions inventory. The 1999 fuel survey was mailed to approximately 84 potential fuel suppliers and dealers. The potential fuel suppliers and dealers were identified from the previous 1995 inventory and telephone directories (i.e., Yellow Pages and electronic).

Annual and monthly fuel sales data were collected for the 1999 inventory year. Fuel sales data were collected for natural gas, propane, coal, distillate fuel (i.e., diesel #1, diesel #2, kerosene, and used diesel fuel), and residual fuel (i.e., heating oil and used fuel oil). In addition, it was initially planned that fuel sales data for firewood would also be collected. However, because commercial firewood suppliers represent such a small fraction of the overall firewood consumption, fuel sales data for firewood were not actively pursued during the survey effort.

3.1.2 Fuel Survey Results

The number of respondents to the fuel survey for each fuel type were:

- Natural gas – 2;
- Propane – 10;
- Distillate – 12;
- Residual – 10; and
- Coal – 2.

Although the number of respondents seems low compared to the number of potential suppliers and dealers, the status of all of the remaining survey recipients was sufficiently researched and their exclusion from the survey results was justified. Reasons for exclusion from the survey results included:

- Out of business;
- Merged with other suppliers;
- Located outside of Ada and Canyon counties with no customers inside the two counties;
- No longer sold fuel; and
- Retail dealer that sold fuel from wholesale supplier already included.

Fuel sales data were disaggregated by county and by use sector (i.e., industrial, commercial/institutional, and residential). Summarized fuel sales data were used to estimate fuel combustion for natural gas, propane, distillate, residual, and coal.

3.2 EMISSION CALCULATION METHODOLOGY – 1999 ANNUAL

For most of the area source categories listed in Table 3-1, 1999 annual emissions were estimated using the general methodology of combining an emission factor with some type of activity data (e.g., fuel consumed, population, number of employees, etc.). In general, emission factors were obtained from U.S. EPA-recommended sources (e.g., AP-42, EIIP guidance documents, etc.). To the greatest extent possible, local activity data were used for emission estimation. However, national- or state-level default values were used when local-level activity data were unavailable. For a few area source categories, a more involved calculation methodology was used.

3.2.1 Residential Wood Combustion

The residential wood combustion area source category included all fireplaces, woodstoves, and barbecues/firepits. The previous 1995 inventory (SAI, 1997) relied upon survey data collected in 1997 (FSC, 1997). Data from this survey was also used in this inventory.

Emissions from residential wood combustion were calculated using the following equation:

$$E_{d,p} = W_d \times EF_{d,p} \times \left(\frac{1\,\text{ton}}{2{,}000\,\text{lbs}} \right)$$

$$W_d = N_d \times U_d \times L_d \times \left(\frac{0.17\,\text{ft}^3}{\text{log}} \right) \times D_d \times \left(\frac{1\,\text{ton}}{2{,}000\,\text{lbs}} \right)$$

where:

$E_{d,p}$ = Emissions for device type d and pollutant p (tons/year);
W_d = Weight of wood consumed by device type d (tons burned/year);
$EF_{d,p}$ = Emission factor for device type d and pollutant p (lbs/tons burned);
N_d = Number of devices of device type d;
U_d = Average annual uses for device type d (uses/year);
L_d = Average fire size for device type d (logs/use); and
D_d = Average wood density for device type d (lbs/ft^3).

A sample calculation using this equation for estimating PM_{10} emissions from Ada County fireplaces is as follows:

where:

N_{fire} = 18,493 devices;
U_{fire} = 35.44 uses/year;
L_{fire} = 6.06 logs/use;
D_{fire} = 35.6 lbs/ft^3;
W_{fire} = 12,018.2 tons wood/year;
$EF_{fire,PM10}$ = 34.6 lbs PM_{10}/ton wood; and
$E_{fire,PM10}$ = 207.9 tons PM_{10}/year.

3.2.2 Other Stationary Source Fuel Combustion

The other stationary source fuel combustion category included all industrial, commercial/ institutional, and residential fuel combustion (except for residential wood combustion). The fuel types include natural gas, propane, fuel oil (distillate and residual), and coal. As described in Section 3.1, a fuel sales data were collected from Ada and Canyon County fuel dealers. Emission factors for natural gas, propane, fuel oil, and coal were obtained from AP-42 (Sections 1.4, 1.3, 1.5, and 1.1, respectively) (U.S. EPA, 1995) and FIRE (U.S.EPA, 2000).

Emissions from other stationary source fuel combustion were calculated using the following equation:

$$E_{f,p} = U_f \times EF_{f,p} \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right)$$

where:

$E_{f,p}$ = Emissions for fuel f and pollutant p (tons/year);
U_f = Fuel usage for fuel f (10^6 ft^3, 10^3 gal or ton); and
$EF_{f,p}$ = Emission factor for fuel f and pollutant p (lb/10^6 ft^3, lb/10^3 gal, or lb/ton).

A sample calculation using this equation for estimating NO_x emissions from Ada County industrial natural gas usage is as follows:

where:

U_{ng} = 6,443.6 MMscf (i.e., 10^6 ft^3);
$EF_{ng,NOx}$ = 94 lbs NO_x/MMscf; and
$E_{ng,NOx}$ = 302.9 tons NO_x/year.

3.2.3 Open Burning

The open burning source category included the following types of open burning: residential municipal solid waste (MSW) burning, residential yard waste burning, agricultural burning, ditch burning, and prescribed fires.

3.2.3.1 Open Burning – Residential MSW and Yard Waste Burning

For residential MSW and yard waste burning, total quantities of waste landfilled were obtained from landfill operators (Hutchinson, 2001; Biddle, 2001). Total quantities of recycled materials were obtained from published reports (Ada, 1999; Ada 2000). The quantity of waste that was landfilled/recycled was then disaggregated into material-specific waste streams (e.g., paper, yard trimmings, etc.) based on national data (Franklin, 1999). Nonburnable materials (i.e., glass and metal) were excluded from further calculations. Based upon recent studies (Thesing and Huntley, 2001), it was assumed that approximately 25 percent of burnable residential MSW is actually burned (i.e., the remaining 75 percent is landfilled or recycled; burned quantities are one-third of landfilled/recycled quantities). In general, emission factors for residential MSW and yard waste burning were obtained from AP-42, Section 2.5 (U.S. EPA, 1995); recent studies have identified a new PM_{10} emission factor for residential MSW burning (Thesing and Huntley, 2001).

Emissions from residential MSW and yard waste burning were calculated using the following equation:

$$E_p = EF_p \times M \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right)$$

where:

E_p = Emissions for pollutant p (tons/year);
EF_p = Emission factor for pollutant p (lbs/ton); and
M = Amount of material burned (tons/year).

A sample calculation using this equation for estimating PM_{10} emissions from Canyon County MSW burning is as follows:

where:

EF_{PM10} = 38 lbs PM_{10}/tons MSW;
M = 26,381 tons MSW/year and
E_{PM10} = 501.2 tons PM_{10}/year.

3.2.3.2 Open Burning – Agricultural Burning

For agricultural burning, total harvested agricultural acreage was obtained from published statistics (IASS, 2000a; IASS, 2000b; IASS, 2000c; NASS, 1999). Agricultural experts identified which crops and what fraction of harvested acreage were typically burned in Ada and Canyon County (Schmollinger, 2001; Takatori, 2001). Fuel loadings and emission factors were obtained from AP-42, Section 2.5 (U.S. EPA, 1995).

Emissions from agricultural burning were calculated using the following equation:

$$E_{p,c} = EF_{p,c} \times AB_c \times BF_c \times FL_c \times \left(\frac{1\text{ ton}}{2{,}000\text{ lbs}} \right)$$

where:

$E_{p,c}$ = Emissions for pollutant p and crop c (tons/year);
$EF_{p,c}$ = Emission factor for pollutant p and crop c (lbs/ton);
AB_c = Acreage burned for crop c (acres/year);
BF_c = Burn fraction for crop c; and
FL_c = Fuel loading for crop c (tons/acre).

A sample calculation using this equation for estimating PM_{10} emissions from Canyon County wheat is as follows:

where:

$EF_{PM10,wheat}$ = 13 lbs PM_{10}/tons;
AB_{wheat} = 36,100 acres;
BF_{wheat} = 0.25;
FL_{wheat} = 1.9 tons/acre; and
E_{PM10} = 111.5 tons PM_{10}/year.

3.2.3.3 Open Burning – Ditch Burning

For ditch burning, an estimate of ditch length was calculated using published statistics of irrigated acreage (BR, 1992) and a ratio of irrigated acreage to ditch length (NM, 2001).

Experts familiar with ditch burning identified a typical burn width and burn fraction (Haines, 2001; Schmollinger, 2001; Simenko, 2001). Fuel loadings and emission factors were obtained from AP-42, Section 2.5 (U.S. EPA, 1995).

Emissions from ditch burning were calculated using the following equation:

$$E_p = EF_p \times AB \times BF \times FL \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right)$$

where:

E_p = Emissions for pollutant p (tons/year);
EF_p = Emission factor for pollutant p (lbs/ton);
AB = Ditch acreage burned (acres/year);
BF = Burn fraction (acres/year); and
FL = Fuel loading (tons/acre).

A sample calculation using this equation for estimating PM_{10} emissions from Canyon County is as follows:

where:

EF_{PM10} = 15 lbs PM_{10}/tons;
AB = 1,962 acres;
BF = 0.10;
FL = 3.2 tons/acre; and
E_{PM10} = 4.7 tons PM_{10}/year.

3.2.3.4 Open Burning – Prescribed Burning

For prescribed burning, an estimate of prescribed burn acreage was calculated by ratioing prescribed burn acreage on Forest Service (USFS) and Bureau of Land Management (BLM) lands in the Great Basin East Area (i.e., Utah and southern Idaho) (NIFC, 1999) by the fraction of land in Ada and Canyon County that was managed by USFS and BLM (IDEQ, 2001; USFS, 2001; BLM, 2001).

Emissions from prescribed burning were calculated using the following equation:

$$E_p = EF_p \times AB \times FL \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right)$$

where:

E_p = Emissions for pollutant p (tons/year);
EF_p = Emission factor for pollutant p (lbs/ton);
AB = Acreage burned (acres/year); and
FL = Fuel loading (tons/acre).

A sample calculation using this equation for estimating PM_{10} emissions from Ada County is as follows:

where:
EF_{PM10} = 23.8 lbs PM_{10}/tons;
AB = 206.6 acres;
FL = 8 tons/acre; and
E_{PM10} = 19.7 tons PM_{10}/year.

3.2.4 Other Fires

The other fire source category included structural fires, vehicle fires, and wildfires. The methodologies for these categories are presented below.

3.2.4.1 Other Fires – Structural Fires and Vehicle Fires

The number of structural and vehicle fires that occurred in Ada and Canyon County was obtained from published statistics (IDOI, 2000). The amount of material burned in a typical structural or vehicle fire, as well as appropriate emission factors was obtained from EIIP guidance documents (EIIP, 2000a; EIIP, 2001a).

Emissions from structural fires and vehicle fires were calculated using the following equation:

$$E_p = EF_p \times F \times M \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right)$$

where:
E_p = Emissions for pollutant p (tons/year);
EF_p = Emission factor for pollutant p (lbs/fire);
F = Annual fires (fires/year); and
M = Material burned per fire (tons/fire).

A sample calculation using this equation for estimating PM_{10} emissions from Ada County is as follows:

where:
EF_{PM10} = 10.8 lbs PM_{10}/tons;
F = 247 structure fires/year;
M = 1.15 tons/fire; and
E_{PM10} = 1.5 tons PM_{10}/year.

3.2.4.2 Other Fires – Wildfires

The wildfire category consists of wildfires occurring on federally-managed lands (assumed to be forest wildfires) and wildfire occurring outside of federally-managed lands (assumed to be grass/brush wildfires). For wildfires on federally-managed lands, an estimate of wildfire acreage was calculated by ratioing wildfire acreage on USFS and BLM lands in the Great

Basin East Area (i.e., Utah and southern Idaho) (NIFC, 1999) by the fraction of land in Ada and Canyon County that was managed by USFS and BLM (IDEQ, 2001; USFS, 2001; BLM, 2001). For wildfires outside of federally-managed lands, an estimate of grass/brush wildfires was obtained from published statistics (IDOI, 2000). Fuel loadings and emission factors were obtained from AP-42, Section 13.1 for wildfires on federally-managed lands and from AP-42, Section 2.5 for wildfires outside of federally-managed lands (U.S. EPA, 1995).

Emissions from wildfires were calculated using the following equation:

$$E_p = EF_p \times AB \times FL \times \left(\frac{1\,\text{ton}}{2{,}000\,\text{lbs}} \right)$$

where:

E_p = Emissions for pollutant p (tons/year);
EF_p = Emission factor for pollutant p (lbs/ton);
AB = Acreage burned (acres/year); and
FL = Fuel loading (tons/acre).

A sample calculation using this equation for estimating PM_{10} emissions from Ada County wildfires on federally-managed lands is as follows:

where:

EF_{PM10} = 17 lbs PM_{10}/tons;
AB = 2,679.8 acres;
FL = 8 tons/acre; and
E_{PM10} = 182.2 tons PM_{10}/year.

3.2.5 Agricultural Windblown Dust

Agricultural acreage was obtained from published agricultural statistics (IASS, 2000a; IASS, 2000b; NASS, 1999). The emission factor was estimated using the USDA wind erosion equation (WEQ) (ARB, 1999a) which is shown below. A location-specific climate factor of 0.355 (‘C’ factor in the WEQ) was derived using Boise meteorological data (i.e., monthly precipitation, monthly average temperature, and average daily wind speed) (INSIDE, 2001). County-specific soil erodibilities (63.9 tons/acre/year for Ada County and 78.1 tons/acre/year for Canyon County) were determined using weighted averages of soil survey data (NRCS, 2001a; NRCS, 2001b).

Emissions from agricultural wind erosion were calculated using the following equation (i.e., WEQ):

$$E_c = EF_c \times A_c$$
$$EF_c = 0.0125 \times I \times C \times K \times L' \times V'$$

where:

E_c = PM_{10} wind erosion emissions for crop c (tons/year);
EF_c = emission factor for crop c (tons PM_{10}/acre/year);
A_c = acres of cropland for crop c;
0.0125 = fraction of suspended particles that are PM_{10};
I = soil erodibility (tons/acre/year);
C = climatic factor (unitless);
K = surface roughness factor (unitless);
L′ = unsheltered field width factor (unitless); and
V′ = vegetative cover factor (unitless).

A sample calculation using this equation for estimating PM_{10} emissions from dry bean fields in Canyon County is as follows:

where:

A_{bean} = 14,100 acres;
I = 78.1 tons/acre/year;
C = 0.355;
K = 0.5;
L′ = 0.64;
V′ = 0.72;
EF_{bean} = 0.08 tons/acre/year; and
E_{bean} = 1,125.7 tons/year.

3.2.6 Other Fugitive Dust

The other fugitive dust category included agricultural tillage, agricultural harvest, beef cattle feedlots, construction activities (not including exhaust emissions), and wind erosion of natural habitat.

3.2.6.1 Other Fugitive Dust – Agricultural Tillage

For agricultural tillage, total planted and harvested agricultural acreage was obtained from published statistics (IASS, 2000a; IASS, 2000b; IASS, 2000c; NASS, 1999). Crop-specific acre-passes were obtained from crop budgets prepared by the University of Idaho specifically for southwestern Idaho (UI, 1999); these were supplemented by information from the California Air Resources Board (ARB) (ARB, 1999b). A region-specific soil silt content was provided by NRCS staff (Harkness, 2001).
Emissions from agricultural tillage were calculated using the following equations:

$$E_c = EF \times A_c \times AP_c \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lbs}} \right)$$

$$EF = k(4.8)(s)^{0.6}$$

where:
E_c = Emissions for crop c (tons PM_{10}/year);
EF = Emission factor (lbs PM_{10}/acre-pass);
A_c = Acreage for crop c (acres/year);
AP_c = Acre-passes for crop c (acre-passes/acre);
k = particle size fraction (0.148 for PM_{10}); and
s = soil silt content (%).

A sample calculation using this equation for estimating PM_{10} emissions from dry bean fields in Canyon County is as follows:

where:
A_{bean} = 14,100 acres/year;
AP_{bean} = 10 acre-passes/acre;
k = 0.148;
s = 50;
EF = 7.43 lbs PM_{10}/acre-pass; and
E_{bean} = 523.7 tons PM_{10}/year.

3.2.6.2 Other Fugitive Dust – Agricultural Harvest

For agricultural harvest, total harvested agricultural acreage was obtained from published statistics (IASS, 2000a; IASS, 2000b; IASS, 2000c; NASS, 1999). Harvest emission factors were obtained from AP-42, Section 9.3 (U.S. EPA, 1995). Emission factors were only available for barley and wheat. As a result, harvest emissions were not estimated for any other crops. However, based upon the fact that estimated emissions for harvest activities associated with barley and wheat were insignificant, it is expected that emissions for other crops will also be insignificant.

Emissions from agricultural harvest activities were calculated using the following equation:

$$E_c = EF_c \times AH_c \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lbs}} \right)$$

where:
E_c = Emissions for crop c (tons PM_{10}/year);
EF_c = Emission factor for crop c (lbs PM_{10}/acre harvested); and
AH_c = Acres harvested for crop c (acres/year).

A sample calculation using this equation for estimating PM_{10} emissions from wheat fields in Canyon County is as follows:

where:
EF_{wheat} = 0.002625 lbs PM_{10}/acre harvested;
AH_{wheat} = 36,100 acres/year; and
E_{wheat} = 0.09 tons PM_{10}/year.

3.2.6.3 Other Fugitive Dust – Beef Cattle Feedlots

Total beef cattle feedlot throughput was estimated based upon published statistics (IASS, 2000d) and information from local livestock experts (Momont, 2001). The emission factor for fugitive dust from beef cattle feedlots was obtained from the ARB (ARB, 1999c).

Emissions from beef cattle feedlots were calculated using the following equation:

$$E = EF \times BC$$

where:
- E = Emissions (tons PM_{10}/year);
- EF = Emission factor (tons PM_{10}/1,000 head throughput); and
- BC = Beef cattle throughput (1,000 head throughput/year).

A sample calculation using this equation for estimating PM_{10} emissions in Canyon County is as follows:

where:
- EF = 17.2 tons PM_{10}/1,000 head throughput;
- BC = 77.89 1,000 head throughput/year; and
- E = 1,339.7 tons PM_{10}/year.

3.2.6.4 Other Fugitive Dust – Construction Activities

The total number of acres with construction activity present was obtained from COMPASS (COMPASS, 2000a; COMPASS, 2000b). The acres for Canyon County were estimated ratioing the Ada County construction acres by the construction values in Ada and Canyon County. The fugitive construction dust emission factor was obtained from a BACM document developed by Midwest Research Institute (MRI, 1996). It was assumed that the duration of construction that represents the level of activity characterized by the MRI emission factor was one month.

Emissions from construction activities were calculated using the following equation:

$$E = EF \times [(A_r \times D_r) + (A_c \times D_c)]$$

where:
- E = PM_{10} emissions (tons/year);
- EF = Emission factor (tons PM_{10}/acre-month);
- A_r = Total area of residential construction for year (acres);
- D_r = Average duration of residential construction (months);
- A_c = Total area of commercial construction for year (acres); and
- D_c = Average duration of commercial construction (months).

A sample calculation using this equation for estimating PM_{10} emissions in Ada County is as follows:

where:

EF = 0.42 tons PM_{10}/month-acre;
A_r = 2,687.54 acres;
D_r = 1 month;
A_c = 116.42 acres; and
D_c = 1 month; and
E = 1,177,7 tons PM_{10}/year.

3.2.6.5 Other Fugitive Dust – Wind Erosion of Natural Habitat

The acreage of non-agricultural land subject to wind erosion (i.e., barren land, rangeland, and other unclassified land) was obtained from the previous 1995 inventory (SAI, 1997). Attempts to get updated acreage for 1999 were unsuccessful. The emission factor was developed from a location-specific rangeland soil loss factor from the Idaho National Resources Inventory (NRCS, 2001c).

Emissions from wind erosion of natural habitat were calculated using the following equation:

$$E = A \times SL \times \left(\frac{0.0125 \text{ ton } PM_{10}}{\text{ton soil loss}} \right)$$

where:

E = PM_{10} emissions (tons/year);
A = Area of undisturbed land (acres); and
SL = Soil loss factor (tons soil loss/acre-year).

A sample calculation using this equation for estimating PM_{10} emissions in Ada County is as follows:

where:

A = 4,264.76 acres;
SL = 0.2 tons soil loss/acre-year; and
E = 10.7 tons/year.

3.2.7 Ammonia Sources

The three significant ammonia sources that were included in the area source inventory were livestock ammonia, fertilizer application, and cold storage ammonia.

3.2.7.1 Livestock Ammonia

Livestock head counts were obtained from published statistics (IASS, 2001d; NASS 1999) and were supplement by information from local livestock experts (Momont, 2001). Livestock ammonia emission factors were obtained from U.S. EPA's ammonia emission factor document (Battye et al., 1994).

Emissions from livestock ammonia were calculated using the following equation:

$$E_{ls} = EF_{ls} \times P_{ls} \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lbs}} \right)$$

where:

E_{ls} = Emissions for livestock type ls (tons NH_3/year);
EF_{ls} = Emission factor for livestock type ls (lbs NH_3/ head livestock); and
P_{ls} = Livestock population for livestock type ls (head livestock/year).

A sample calculation using this equation for estimating NH_3 emissions for dairy cows in Ada County is as follows:

where:

EF_{ls} = 87.57 lbs NH_3/ head-year;
P_{ls} = 18,000 dairy cows; and
E_{ls} = 788.1 tons NH_3/year.

3.2.7.2 Fertilizer Application

For fertilizer application, total planted and harvested agricultural acreage was obtained from published statistics (IASS, 2000a; IASS, 2000b; IASS, 2000c; NASS, 1999). Application procedures and quantities were obtained from crop budgets prepared by the University of Idaho agricultural experts specifically for southwestern Idaho (UI, 1999; Patterson and Smathers, 2000). Fertilizer-specific emission factors were obtained from U.S. EPA's ammonia emission factor document (Battye et al., 1994).

Emissions from fertilizer application were calculated using the following equation:

$$E_{f,c} = A_c \times AR_{f,c} \times N_f \times \left(\frac{1 \text{ ton N}}{2{,}000 \text{ lbs N}} \right) \times EF_f \times \left(\frac{1 \text{ ton } NH_3}{2{,}000 \text{ lbs } NH_3} \right)$$

where:

$E_{f,c}$ = Emissions for fertilizer type f on crop c(tons NH_3/year);
A_c = Acreage of crop c (acres/year);
$AR_{f,c}$ = Application rate for fertilizer type f on crop c (lbs fertilizer/acre);
N_f = Nitrogen content of fertilizer type f (%); and
EF_f = Emission factor for fertilizer type f (lb NH_3/ton total N).

A sample calculation using this equation for estimating NH_3 emissions for urea application on peppermint in Canyon County is as follows:

where:

A_c = 8,622 acres/year;
$AR_{f,c}$ = 215 lbs urea/acre;
N_f = 46% nitrogen content;
EF_f = 364 lb NH_3/ton total N; and
$E_{f,c}$ = 77.6 tons NH_3/year.

3.2.7.3 Cold Storage Ammonia

County employee statistics for relevant NAICS codes (previously SIC codes) were obtained from the Census Bureau (U.S. Census, 2001). A per employee emission factor was derived from national level employee statistics (U.S. Census, 2001) and national ammonia refrigerant use statistics contained in U.S. EPA's ammonia emission factor document (Battye et al., 1994).

The equation for estimating cold storage ammonia emissions using per employee emission factors is:

$$E = EF \times EM \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right)$$

where:

E = NH_3 emissions (tons/year);
EF = NH_3 per employee emission factor (lbs/employee-year); and
EM = Number of employees (people).

A sample calculation using this equation for estimating emissions in Ada County is as follows:

where:

EF = 370.6 lbs NH_3/employee-year;
EM = 1,487 employees; and
E = 275.5 tons NH_3 year.

3.2.8 Biogenic Sources

Biogenic sources in Ada and Canyon County emit VOC and microbial NO. An existing 1997 county-level biogenic emissions inventory was previously prepared by U.S. EPA (U.S. EPA, 1997). These emission estimates were estimated using the PC-BEIS biogenic emissions model. This existing inventory contains isoprene, monoterpene, other VOC, and NO emissions. The isoprene, monoterpene, and other VOC emissions were aggregated together to estimate total VOC emissions. It was assumed that the existing 1997 annual biogenic emissions inventory would be representative of the 1999 annual emissions. an existing 1997 county-level biogenic emissions inventory has been prepared by U.S. EPA. This inventory was used to provide biogenic emission estimates for Ada and Canyon counties.

3.2.9 VOC Sources

VOC sources include gasoline distribution, aviation refueling, autobody refinishing, architectural surface coating, dry cleaning, consumer solvent use, solvent degreasing, graphic arts, industrial surface coating, pesticides, traffic markings, and asphalt paving.

3.2.9.1. VOC Sources – Gasoline Distribution

The gasoline distribution source category included five subcategories: Stage I (i.e., underground tank filling), Stage II (i.e., vehicle refueling), underground tank breathing, tank truck transit, and aviation refueling.

County-level gasoline sales were estimated by disaggregating state-level fuel sales (FHWA, 2000) using state and county vehicle registrations (ITD). Additional information regarding Stage I was provided by IDEQ staff (Jarvis, 2001). Aviation fuel usage information was also provided by IDEQ staff (DuBois, 2001).

Emission factors for Stage I, underground tank breathing, and tank truck transit were obtained from EIIP guidance (EIIP, 2001b). Emission factors for Stage II were developed using MOBILE6 in conjunction with the on-road mobile source inventory (see Section 4.0) (U.S. EPA, 2001). Emissions factors for aviation refueling were obtained from AP-42, Section 5.2 (U.S. EPA, 1995).

Emissions from gasoline distribution and aviation refueling were calculated using the following equation:

$$E = EF \times T \times \left(\frac{1\,\text{ton}}{2{,}000\,\text{lbs}} \right)$$

where:
E = Emissions (tons VOC/year);
EF = Emission factor (lbs/gal throughput); and
T = Annual fuel throughput (gal/year).

A sample calculation using this equation for estimating emissions for Stage II refueling in Ada County is as follows:

where:
EF = 3.91 lbs VOC/1000 gallons;
T = 142,235 1000 gallons/year; and
E = 278.1 tons VOC/year.

3.2.9.2 VOC Sources – Per Capita Emission Factors

The following VOC source categories were estimated using per capita emission factors: architectural surface coatings, consumer solvent use, graphic arts, traffic markings, and industrial surface coating (some subcategories). Population statistics were obtained from the

Census Bureau (U.S. Census, 2001). Per employee emission factors were obtained from EIIP guidance (EIIP, 1995; EIIP, 1996b; EIIP, 1996c; EIIP, 1997c; EIIP, 1997b). National paint statistics were used to develop the per capita emission factors for architectural surface coatings and traffic markings (U.S. Census, 2000b).

The equation for estimating VOC source category emissions using per capita emission factors is:

$$E = EF \times P \times \left(\frac{1\,\text{ton}}{2{,}000\,\text{lbs}} \right)$$

where:

E = VOC emissions (tons/year);
EF = VOC per capita emission factor (lbs/person-year); and
P = Population (people).

A sample calculation using this equation for estimating emissions for consumer solvent use in Ada County is as follows (the calculation is similar for the architectural surface coating, graphic arts, traffic markings, and relevant industrial surface coating source categories):

where:

EF = 7.84 lbs VOC/person-year;
P = 283,402 people; and
E = 1,110.9 tons VOC year.

3.2.9.3 VOC Sources – Per Employee Emission Factors

The following VOC source categories were estimated using per employee emission factors: autobody refinishing, dry cleaning, degreasing, and industrial surface coating (some subcategories). County employee statistics for relevant NAICS codes (previously SIC codes) were obtained from the Census Bureau (U.S. Census, 2001). Per employee emission factors were obtained from EIIP guidance (EIIP, 2000b; EIIP, 1996a; EIIP, 1997a; EIIP, 1997b).

The equation for estimating VOC source category emissions using per employee emission factors is:

$$E = EF \times EM \times \left(\frac{1\,\text{ton}}{2{,}000\,\text{lbs}} \right)$$

where:

E = VOC emissions (tons/year);
EF = VOC per employee emission factor (lbs/employee-year); and
EM = Number of employees (people).

A sample calculation using this equation for estimating emissions for dry cleaning in Ada County is as follows (the calculation is similar for the autobody refinishing, degreasing, and relevant industrial surface coating source categories):

where:

EF = 1,800 lbs VOC/employee-year;
EM = 325 employees; and
E = 292.5 tons VOC year.

3.2.9.4 VOC Sources – Pesticide Application

For pesticide application, total planted and harvested agricultural acreage was obtained from published statistics (IASS, 2000a; IASS, 2000b; IASS, 2000c; NASS, 1999). Application procedures were obtained for Idaho-specific integrated pest management crop profiles prepared by pesticide experts at North Carolina State University (NCSU, 2001). Pesticide properties were obtained from an on-line pesticide database (CDMS, 2001) and the EIIP guidance document (EIIP, 2001c). Emission factors were obtained from the EIIP guidance document (EIIP, 2001c). The emission factors are a function of the active vapor pressure. Only pesticides and herbicides were applied; other agricultural chemical applications (i.e., seed treatments, oils, thinners, sprout inhibitors, fumigants, desiccants, fruit drop preventing chemicals, fruit shape improving chemicals, and rodenticides) were not considered.

Emissions from pesticide application were calculated using the following equation:

$$E_{p,t} = E_{p,a} + E_{p,i}$$

$$E_{p,a} = \left(R_{p,a} \times A_p \times \frac{1\text{ ton pest}}{2{,}000\text{ lbs pest}} \times EF_p \times \frac{1\text{ ton VOC}}{2{,}000\text{ lbs VOC}} \right)$$

$$E_{p,i} = \left(R_{p,i} \times A_p \times V_p \times \frac{1\text{ ton VOC}}{2{,}000\text{ lbs VOC}} \right)$$

where:

$E_{p,t}$ = Total emissions from pesticide p (tons VOC/year);
$E_{p,a}$ = Emissions from active ingredient of pesticide p (tons VOC/year);
$E_{p,i}$ = Emissions from inert ingredient of pesticide p (tons VOC/year);
$R_{p,a}$ = Application rate of pesticide p active ingredient (lbs/acre-year);
$R_{p,i}$ = Application rate of pesticide p inert ingredient (lbs/acre-year);
A_p = Acreage that had application of pesticide p (acres);
EF_p = Emission factor for active ingredient in pesticide p (lbs/ton);
i_p = Percent of inert ingredient in pesticide p (%); and
V_p = Volatile content of inert fraction of pesticide p (%).

A sample calculation using this equation for estimating emissions from EPTC (Eradicane) application on dry beans in Canyon County is as follows:

where:

$R_{p,a}$ = 3 lbs/acre-year;
A_p = 5,640 acres;
EF_p = 1,160 lbs/ton;
$R_{p,i}$ = 0.63 lbs/acre-year;
V_p = 56%

$E_{p,a}$ = 4.9 tons VOC/year;
$E_{p,i}$ = 1.0 tons VOC/year; and
$E_{p,t}$ = 5.9 tons VOC/year).

3.2.9.5 VOC Sources – Asphalt Paving

Emissions from asphalt paving were estimated using asphalt usage estimates and asphalt characteristics provided by asphalt manufacturers. Estimates were limited to usage within Ada and Canyon County. Emissions were estimated only for medium-cure cutback asphalt (i.e. MC-800 and MC-3000). The methodology is based upon EIIP guidance documents (EIIP, 2001d).

Emissions from asphalt paving were calculated using the following equation:

$$E = M_a \times w\%_d \times e_d$$

where:
E = Emissions (tons VOC/year);
M_a = Mass of asphalt applied (tons/year);
$w\%_d$ = Weight percent of diluent in asphalt (%); and
e_d = Percent of diluent evaporated (%).

A sample calculation using this equation for estimating emissions from MC-800 in Ada County is as follows:

where:
M_a = 375 tons/year;
$w\%_d$ = 28%;
e_d = 70%; and
E = 73.5 tons VOC/year.

3.2.10 Charbroiling

Emissions from charbroiling were estimated using a methodology previously employed in the Denver PM_{10} inventory (RAQC, 2001). The methodology was based upon annual per capita meat consumption and an estimated fraction of meals eaten away from home (RAQC, 2001). In addition, the estimated fraction of meat that is charbroiled was estimated from sales data of various types of restaurants (U.S. Census, 2000c). Population statistics were obtained from U.S. Census data (U.S. Census, 2000a).

Emissions from charbroiling were calculated using the following equation:

$$E = P \times MC \times R \times CB \times EF \times \frac{\text{ton } PM_{10}}{2{,}000 \text{ lbs } PM_{10}}$$

where:

E = Emissions (tons PM_{10}/year);
P = Population (people);
MC = Meat consumption (lbs meat/person-year);
R = Fraction of meat consumed in restaurants (%);
CB = Fraction of restaurant meat that is charbroiled; and
EF = lbs PM_{10}/1000 lbs meat.

A sample calculation using this equation for estimating emissions in Ada County is as follows:

where:

P = 283,402 people;
MC = 234 lbs meat/person-year;
R = 0.5;
CB = 0.1532;
EF = 23.23 lbs PM_{10}/1000 lbs meat;
E = 59.0 tons PM_{10}/year.

3.2.11 Point Source/Area Source Reconciliation

In order to avoid double-counting of emissions between the industrial point source inventory and the area source inventory, reconciliation was performed after annual area source emissions were calculated. This reconciliation was conducted in two ways: fuel use reconciliation and emission reconciliation.

The fuel use in the following area source fuel combustion categories were adjusted downward due to industrial point source fuel use identified during the point source questionnaire survey process:

- Natural gas – Ada county industrial, Canyon county industrial, and Canyon county commercial/institutional;

- Propane – Ada county industrial and Canyon county industrial;

- Distillate fuel oil – Ada county industrial, Canyon county industrial, and Ada county commercial/institutional; and

- Residual fuel oil – Canyon county industrial and Canyon county commercial/institutional.

Industrial point source fuel use was first subtracted from the industrial area source fuel combustion categories and then from the commercial/institutional area source fuel combustion categories. This reconciliation was conducted separately for Ada and Canyon County. Industrial point source fuel use was not subtracted from the residential area source fuel combustion categories, even if the fuel use quantity exceeded the combined industrial and commercial/institutional fuel combustion categories.

Emissions in the following area source categories were adjusted downward due to emissions that were already included in the industrial point source inventory: cold storage ammonia, degreasing (some subcategories), and industrial surface coating (some subcategories). These emissions were identified in the point source database because their respective processes also were included in the area source inventory.

3.3 EMISSION CALCULATION METHODOLOGY – 1999 EPISODE

After annual emission estimates were calculated for Ada and Canyon County area sources, 1999 daily episode emission estimates were then calculated. The 1999 episode was from Monday, December 20 through Sunday, December 26. For the purposes of estimating 1999 daily episode area source emissions, the weekdays were considered to be December 20-23 and the weekend days were considered to be December 24-26. Although December 24 (Christmas Eve) was a Friday, area source behavior on that day was expected to be similar to typical weekend behavior.

3.3.1 Identification of Area Sources Active During Winter

The first step in estimating the 1999 daily episode emissions was to identify those area source categories that were actually active during the winter (i.e., December). These categories are shown in Table 3-2. Based upon the local agricultural schedule, some agricultural sources are known not to be conducted in December (i.e., agricultural open burning, tillage, harvest, fertilizer application, pesticide application). Because of low wind speeds during the entire 1999 episode, wind-related area sources categories (i.e., agricultural windblown dust and wind erosion from natural habitats) were also not active. Area source categories that involved outdoor application of VOC (i.e., architectural surface coatings, traffic markings, and asphalt paving) were also assumed to be not active during December.

3.3.2 Identification of Area Sources Active During Episode Weekdays and Weekend Days

The next step in estimating 1999 daily episode emissions was to identify those area source categories that were active during the episode weekdays (i.e., December 20-23) and weekend days (i.e., December 24-26). These are also identified in Table 3-2. All area source categories that were active during the winter were active during the episode weekdays. During the episode weekend days, those area source categories that are commercial or light industrial in nature (i.e., autobody refinishing, solvent degreasing, graphic arts, industrial surface coating) were assumed to be not active (i.e., shut down for the Christmas holiday). As shown in Table 3-2, the only source categories active during the episode weekend days were residential wood combustion, other fuel combustion, structural and vehicle fires, beef cattle feedlots, livestock ammonia, cold storage ammonia, biogenic emissions, gasoline distribution, consumer solvent use, and charbroiling.

3.3.3 1999 Episode Emission Calculation Methodology – General

After identifying those area source categories that were active during the episode weekdays and weekend days, daily episode emissions were calculated. For most area source categories, the daily episode emissions were calculated to be the annual average daily emissions (i.e., annual emissions divided by 365). These are presented in Table 3-2. For a few area source categories, the daily episode emissions were estimated using some other methodology than annual average daily emissions. These methodologies are described below.

3.3.3.1 1999 Episode Emission Calculation Methodology – Residential Wood Combustion

The 1999 daily episode emissions for residential wood combustion (i.e. fireplaces and woodstoves) were estimated using by applying three adjustment factors to average daily emissions. The first adjustment factor was developed to adjust average monthly device usage to December monthly device usage based upon survey data collected in 1997 for the previous 1995 inventory (FSC, 1997). The second adjustment factor was developed to adjust average daily wood consumption to average weekday and weekend day daily wood consumption; this adjustment factor was also based upon the 1997 survey data (FSC, 1997). This adjustment factor was developed using the modified week with four weekdays and three weekend days rather than the tradition week with five weekdays and two weekend days (see Section 3.3). The third adjustment factor was based upon the difference in December heating degree days (HDD) for 1996 (i.e., period covered by the April 1997 survey) and 1999 (i.e., the inventory year) (INSIDE, 2001).

3.3.3.2 1999 Episode Emission Calculation Methodology – Other Fuel Combustion

The 1999 daily episode emissions for other fuel combustion (i.e. natural gas, propane, distillate fuel, residual fuel, and coal) were estimated by applying an adjustment factor based upon average December daily fuel usage relative to average annual daily fuel usage. The fuel survey described in Section 3.1.1 requested both annual and monthly fuel sales data for 1999. Specific adjustment factors were estimated for industrial, commercial/institutional, and residential fuel use for each fuel type in both Ada and Canyon County.

3.3.3.3 1999 Episode Emission Calculation Methodology – Beef Cattle Feedlots

Based upon IDEQ staff knowledge of local beef cattle feedlots, an adjustment factor of 0.500 was used for episode weekdays and an adjustment factor of 0.000 was used for episode weekend days (Baldwin, 2001). The basis for the weekday adjustment factor was high humidity, moisture cover, and freezing ground. The basis for the weekend day adjustment factor was precipitation.

3.3.3.4 1999 Episode Emission Calculation Methodology – Biogenic Emissions

As described in Section 3.2.8, an existing 1997 biogenics inventory developed by U.S. EPA was used to represent the annual 1999 biogenc emissions in Ada and Canyon Counties (U.S. EPA, 1997). However, the use of December 20-26 biogenic emissions data from the 1997 inventory to represent the December 20-26, 1999 episode was not a reasonable assumption, because biogenic emissions are very dependent upon hourly meteorological conditions and solar intensity. Hourly biogenic emissions were therefore calculated for the 1999 modeling episode using PC-BEIS. PC-BEIS was supplied with average hourly temperature and cloud cover data from the NWS Boise airport site for the same three sets of days used to develop the on-road mobile inventory (December 20-23, December 24, and December 25-26). The program includes internal algorithms to calculate solar angle based on time of day, day of year, and centroid latitude/longitude of each county requested for output. PC-BEIS was used to provide county-level biogenic VOC and soil NOx for all counties in the modeling domain, including Ada, Canyon, Boise, Owyhee, Gem, and Payette in Idaho, and Malheur in Oregon. The resulting biogenic VOC and NOx emission estimates were quite low for all counties because of the season and the cold, often cloud-covered conditions during the episode period.

3.3.3.5 1999 Episode Emission Calculation Methodology – Gasoline Distribution (Stage II)

The 1999 daily episode emissions for Stage II vehicle refueling were estimated by applying an adjustment factor based upon the annual average vehicle refueling emission factor and the average winter vehicle refueling emission factor for Ada and Canyon County. As described in Section 3.2.9.1, both of these emission factors were developed using MOBILE6 in conjunction with the on-road mobile source inventory (see Section 4.0) (U.S. EPA, 2001).

3.4 EMISSIONS BY SOURCE CATEGORY

Table 3-1 shows the results of the 1999 annual emissions inventory for area sources located within Ada and Canyon Counties. The area source categories are generally listed with the (primary) PM_{10} categories on top. Total 1999 PM_{10} area source emissions for both counties were 21,775 tons. This total is less than the 1995 inventory total of 26,542 tons. Some discrepancies between the 1995 and 1999 inventories are expected due to different data quality and methodologies. The total 1999 NO_x, SO_x, and NH_3 area source emissions were 1,734 tons, 103 tons, and 6,260 tons, respectively. Compared to the 1995 inventories (i.e., 2,030 tons NO_x, 139 tons SO_x, and 10,162 tons NH_3), all of the 1999 emissions are less. VOC and CO emissions were not estimated as part of the 1995 area source inventory.

Tables 3-2a and 3-2b summarize the results of the 1999 episode emissions inventory for area sources that were present in Ada and Canyon counties during the week of December 20-26, 1999. Average winter weekday and average winter weekend day emissions for all pollutants are presented in Table 3-2a and Table 3-2b, respectively. Because Christmas Eve and Christmas Day fell on Friday and Saturday during the episode in 1999, December 24 through December 26 were treated as weekend days and December 20 through December 23 were treated as weekdays. This split of the episode into weekdays and weekend also coincides with the periods of no precipitation (i.e., December 20-23) and precipitation (i.e., December 24-26) during the one week episode. Some source categories had zero emissions throughout the 1999 episode (e.g., wind speeds did not exceed the 15 mph threshold needed to generate agricultural windblown dust, fertilizer and pesticide application is not conducted in the winter, etc.). Other source categories were assumed to have operated normally during the first part of the episode (i.e, December 20-23), but shut down for the Christmas holiday (i.e., December 24-26). These source categories included autobody refinishing, solvent degreasing, dry cleaning, etc. Finally, average winter weekday and winter weekend day emissions were adjusted to account for seasonal variations. These categories included residential wood combustion, other fuel combustion, feedlots, gasoline distribution, and biogenics.

3.5 DATA MANAGEMENT AND QUALITY ASSURANCE/QUALITY CONTROL

Area source emissions were calculated using Excel spreadsheets. A separate spreadsheet was developed for each area source category. A summary spreadsheet was then developed which linked to each of the individual source category spreadsheets.

In general, procedures described in *Final Inventory Preparation Plan/Quality Assurance Plan (IPP/QAP)* (ENVIRON, 2001) were used to check, and correct when necessary, the area source emissions estimates. In particular, all area source emission calculations were internally checked by ERG staff. In addition, area source emission estimates were also reviewed by IDEQ staff and other inventory stakeholders.

Table 3-1. 1999 area sources annual emissions by source category (tons).

	Ada						Canyon					
Area Source Category	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	211.7	15.9	2.4	1,401.0	1,545.4	0.0	73.3	5.5	0.8	484.9	534.9	0.0
Residential Wood Combustion (Woodstoves)	138.4	15.9	2.4	174.0	979.9	0.0	102.3	11.2	1.6	148.9	770.7	0.0
Other Fuel Combustion (Industrial Natural Gas)	6.8	249.7	0.5	4.9	74.9	2.9	0.0	0.0	0.0	0.0	0.0	0.0
Other Fuel Combustion (Comm/Inst Natural Gas)	12.3	162.4	1.0	8.9	136.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0
Other Fuel Combustion (Residential Natural Gas)	24.5	302.9	1.9	17.7	128.9	1.6	5.5	68.2	0.4	4.0	29.0	0.4
Other Fuel Combustion (Industrial Propane)	0.3	8.0	0.0	0.1	1.4	0.0	0.2	4.8	0.0	0.1	0.8	0.0
Other Fuel Combustion (Comm/Inst Propane)	0.3	10.7	0.0	0.2	1.5	0.0	0.1	4.1	0.0	0.1	0.6	0.0
Other Fuel Combustion (Residential Propane)	0.3	12.2	0.0	0.3	1.6	0.0	0.3	12.2	0.0	0.3	1.7	0.0
Other Fuel Combustion (Industrial Distillate)	0.0	0.0	0.0	0.0	0.0	0.0	1.9	13.8	19.9	0.1	2.9	0.5
Other Fuel Combustion (Comm/Inst Distillate)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Fuel Combustion (Residential Distillate)	0.2	2.1	3.7	0.1	0.6	0.1	0.0	0.4	0.7	0.0	0.1	0.0
Other Fuel Combustion (Industrial Residual)	0.1	0.6	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Fuel Combustion (Comm/Inst Residual)	0.2	0.5	0.8	0.0	0.1	0.0	0.1	0.2	0.3	0.0	0.0	0.0
Other Fuel Combustion (Residential Residual)	2.3	5.4	8.9	0.2	1.3	0.2	4.0	9.5	15.6	0.3	2.4	0.4
Other Fuel Combustion (Residential Coal)	0.7	1.0	2.0	1.1	29.8	0.0	1.5	2.3	4.6	2.5	68.2	0.0
Open Burning (Residential MSW)	820.7	129.6	21.6	647.9	1,835.9	0.0	501.2	79.1	13.2	395.7	1,121.2	0.0
Open Burning (Residential Yard Waste)	141.8	0.0	0.0	104.5	417.8	0.0	86.6	0.0	0.0	63.8	255.2	0.0
Open Burning (Agricultural Fields)	62.2	0.0	0.0	47.5	437.9	0.0	256.2	0.0	0.0	209.8	1,634.7	0.0
Open Burning (Ditches)	1.9	0.0	0.0	1.2	11.0	0.0	4.7	0.0	0.0	2.8	26.7	0.0
Open Burning (Prescribed)	19.7	0.0	0.0	6.4	137.9	0.0	0.9	0.0	0.0	0.3	6.4	0.0
Other Fires (Structural)	1.5	0.2	0.0	1.6	8.5	0.0	0.9	0.1	0.0	0.9	5.0	0.0
Other Fires (Vehicles)	2.2	0.1	0.0	0.7	2.7	0.0	1.3	0.1	0.0	0.4	1.6	0.0
Other Fires (Wildfires)	182.9	42.9	0.0	257.7	1,504.4	0.0	9.6	2.2	0.0	13.3	78.5	0.0
Agricultural Windblown Dust	1,725.1	0.0	0.0	0.0	0.0	0.0	8,810.2	0.0	0.0	0.0	0.0	0.0
Fugitive Dust (Tillage)	1,161.2	0.0	0.0	0.0	0.0	0.0	4,049.4	0.0	0.0	0.0	0.0	0.0
Fugitive Dust (Harvest)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Fugitive Dust (Feedlots)	260.6	0.0	0.0	0.0	0.0	0.0	1,339.7	0.0	0.0	0.0	0.0	0.0
Fugitive Dust (Construction Activities)	1,177.7	0.0	0.0	0.0	0.0	0.0	472.0	0.0	0.0	0.0	0.0	0.0
Fugitive Dust (Natural Wind Erosion)	10.7	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0
Livestock Ammonia	0.0	0.0	0.0	0.0	0.0	1,659.5	0.0	0.0	0.0	0.0	0.0	2,731.5
Fertilizer Ammonia	0.0	0.0	0.0	0.0	0.0	242.0	0.0	0.0	0.0	0.0	0.0	736.0
Cold Storage Ammonia	0.0	0.0	0.0	0.0	0.0	275.5	0.0	0.0	0.0	0.0	0.0	608.6
Biogenic Emissions	0.0	394.3	0.0	4,801.7	0.0	0.0	0.0	166.5	0.0	6,288.2	0.0	0.0
Gasoline Distribution (Stage I)	0.0	0.0	0.0	817.9	0.0	0.0	0.0	0.0	0.0	382.1	0.0	0.0
Gasoline Distribution (Stage II)	0.0	0.0	0.0	278.1	0.0	0.0	0.0	0.0	0.0	129.9	0.0	0.0
Gasoline Distribution (Underground Tank)	0.0	0.0	0.0	71.1	0.0	0.0	0.0	0.0	0.0	33.2	0.0	0.0
Gasoline Distribution (Tank Truck Transit)	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0
Aviation Refueling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Autobody Refinishing	0.0	0.0	0.0	85.1	0.0	0.0	0.0	0.0	0.0	32.7	0.0	0.0
Architectural Surface Coating	0.0	0.0	0.0	496.6	0.0	0.0	0.0	0.0	0.0	218.1	0.0	0.0
Dry Cleaning	0.0	0.0	0.0	292.5	0.0	0.0	0.0	0.0	0.0	54.0	0.0	0.0
Consumer Solvent Use	0.0	0.0	0.0	1,110.9	0.0	0.0	0.0	0.0	0.0	487.8	0.0	0.0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0.0	0.0	0.0	481.5	0.0	0.0	0.0	0.0	0.0	182.0	0.0	0.0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0.0	0.0	0.0	171.8	0.0	0.0	0.0	0.0	0.0	22.2	0.0	0.0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and I	0.0	0.0	0.0	21.0	0.0	0.0	0.0	0.0	0.0	32.6	0.0	0.0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0.0	0.0	0.0	41.4	0.0	0.0	0.0	0.0	0.0	36.6	0.0	0.0
Graphic Arts	0.0	0.0	0.0	184.2	0.0	0.0	0.0	0.0	0.0	80.9	0.0	0.0
Surface Coating (Factory Finished Wood)	0.0	0.0	0.0	120.9	0.0	0.0	0.0	0.0	0.0	13.8	0.0	0.0
Surface Coating (Wood Furniture)	0.0	0.0	0.0	172.3	0.0	0.0	0.0	0.0	0.0	56.6	0.0	0.0
Surface Coating (Misc. Finished Metals)	0.0	0.0	0.0	83.5	0.0	0.0	0.0	0.0	0.0	14.4	0.0	0.0
Surface Coating (Machinery and Equipment)	0.0	0.0	0.0	122.4	0.0	0.0	0.0	0.0	0.0	78.9	0.0	0.0
Surface Coating (Motor Vehicles)	0.0	0.0	0.0	273.9	0.0	0.0	0.0	0.0	0.0	163.6	0.0	0.0
Surface Coating (Marine)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Surface Coating (Railroad)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0
Surface Coating (Misc. Manufacturing)	0.0	0.0	0.0	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surface Coating (Industrial Maintenance Coatings)	0.0	0.0	0.0	85.0	0.0	0.0	0.0	0.0	0.0	37.3	0.0	0.0
Surface Coating (Other Special Purpose Coatings)	0.0	0.0	0.0	113.4	0.0	0.0	0.0	0.0	0.0	49.8	0.0	0.0
Pesticides	0.0	0.0	0.0	140.1	0.0	0.0	0.0	0.0	0.0	583.0	0.0	0.0
Traffic Markings	0.0	0.0	0.0	61.6	0.0	0.0	0.0	0.0	0.0	27.1	0.0	0.0
Asphalt Paving	0.0	0.0	0.0	126.0	0.0	0.0	0.0	0.0	0.0	134.4	0.0	0.0
Charbroiling	59.0	0.0	0.0	0.0	0.0	0.0	25.9	0.0	0.0	0.0	0.0	0.0
Total	**6,025.2**	**1,354.2**	**45.7**	**12,840.8**	**7,258.0**	**2,182.7**	**15,749.7**	**380.2**	**57.3**	**10,472.0**	**4,540.4**	**4,077.3**

Table 3-2a. 1999 winter weekday emissions for Ada and Canyon Counties (lbs/day).

	Ada						Canyon					
Area Source Category	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	1,961	147	23	12,982	14,320	0	640	48	7	4,234	4,670	0
Residential Wood Combustion (Woodstoves)	2,194	251	37	2,759	15,540	0	1,430	156	22	2,082	10,772	0
Other Fuel Combustion (Industrial Natural Gas)	50	1,837	4	36	551	21	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Natural Gas)	102	1,339	8	74	1,125	7	0	0	0	0	0	0
Other Fuel Combustion (Residential Natural Gas)	219	2,705	17	158	1,151	14	56	698	4	41	297	4
Other Fuel Combustion (Industrial Propane)	2	68	0	1	11	0	1	44	0	1	7	0
Other Fuel Combustion (Comm/Inst Propane)	2	83	0	2	11	0	1	37	0	1	5	0
Other Fuel Combustion (Residential Propane)	3	105	0	2	14	0	3	111	0	2	15	0
Other Fuel Combustion (Industrial Distillate)	0	0	0	0	0	0	10	71	103	1	15	2
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	3	27	47	1	7	1	1	9	15	0	2	0
Other Fuel Combustion (Industrial Residual)	1	3	2	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	3	6	10	0	2	0	1	2	3	0	1	0
Other Fuel Combustion (Residential Residual)	29	68	112	2	17	3	51	120	197	4	30	5
Other Fuel Combustion (Residential Coal)	8	12	25	13	366	0	23	34	69	37	1,020	0
Open Burning (Residential MSW)	4,497	710	118	3,550	10,059	0	2,746	434	72	2,168	6,143	0
Open Burning (Residential Yard Waste)	777	0	0	572	2,289	0	474	0	0	350	1,398	0
Open Burning (Agricultural Fields)	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Ditches)	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Prescribed)	0	0	0	0	0	0	0	0	0	0	0	0
Other Fires (Structural)	8	1	0	9	47	0	5	1	0	5	27	0
Other Fires (Vehicles)	12	0	0	4	15	0	7	0	0	2	9	0
Other Fires (Wildfires)	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Windblown Dust	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Tillage)	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	714	0	0	0	0	0	3,670	0	0	0	0	0
Fugitive Dust (Construction Activities)	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	0	0	0	0	0	0	0	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	9,093	0	0	0	0	0	14,967
Fertilizer Ammonia	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage Ammonia	0	0	0	0	0	1,510	0	0	0	0	0	3,335
Biogenic Emissions	0	941	0	2,374	0	0	0	408	0	3,375	0	0
Gasoline Distribution (Stage I)	0	0	0	4,481	0	0	0	0	0	2,094	0	0
Gasoline Distribution (Stage II)	0	0	0	1,648	0	0	0	0	0	770	0	0
Gasoline Distribution (Underground Tank)	0	0	0	390	0	0	0	0	0	182	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	29	0	0	0	0	0	14	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	2	0	0
Autobody Refinishing	0	0	0	466	0	0	0	0	0	179	0	0
Architectural Surface Coating	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	1,603	0	0	0	0	0	296	0	0
Consumer Solvent Use	0	0	0	6,087	0	0	0	0	0	2,673	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	2,639	0	0	0	0	0	997	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	941	0	0	0	0	0	122	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and Electrical)	0	0	0	115	0	0	0	0	0	178	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	227	0	0	0	0	0	201	0	0
Graphic Arts	0	0	0	1,009	0	0	0	0	0	443	0	0
Surface Coating (Factory Finished Wood)	0	0	0	663	0	0	0	0	0	76	0	0
Surface Coating (Wood Furniture)	0	0	0	944	0	0	0	0	0	310	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	457	0	0	0	0	0	79	0	0
Surface Coating (Machinery and Equipment)	0	0	0	671	0	0	0	0	0	432	0	0
Surface Coating (Motor Vehicles)	0	0	0	1,501	0	0	0	0	0	896	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	2	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	7	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	36	0	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	466	0	0	0	0	0	205	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	621	0	0	0	0	0	273	0	0
Pesticides	0	0	0	0	0	0	0	0	0	0	0	0
Traffic Markings	0	0	0	0	0	0	0	0	0	0	0	0
Asphalt Paving	0	0	0	0	0	0	0	0	0	0	0	0
Charbroiling	323	0	0	0	0	0	142	0	0	0	0	0
Total	**10,908**	**8,304**	**403**	**47,535**	**45,525**	**10,649**	**9,263**	**2,172**	**494**	**22,733**	**24,412**	**18,313**

Note: Open burning emissions were zeroed out for air quality modeling.

Table 3-2b. 1999 winter weekend day emissions for Ada and Canyon Counties (lbs/day).

	Ada						Canyon					
Area Source Category	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	4,267	321	49	28,241	31,151	0	1,392	105	16	9,211	10,160	0
Residential Wood Combustion (Woodstoves)	2,705	310	46	3,402	19,159	0	1,764	192	27	2,566	13,280	0
Other Fuel Combustion (Industrial Natural Gas)	50	1,837	4	36	551	21	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Natural Gas)	102	1,339	8	74	1,125	7	0	0	0	0	0	0
Other Fuel Combustion (Residential Natural Gas)	219	2,705	17	158	1,151	14	56	698	4	41	297	4
Other Fuel Combustion (Industrial Propane)	2	68	0	1	11	0	1	44	0	1	7	0
Other Fuel Combustion (Comm/Inst Propane)	2	83	0	2	11	0	1	37	0	1	5	0
Other Fuel Combustion (Residential Propane)	3	105	0	2	14	0	3	111	0	2	15	0
Other Fuel Combustion (Industrial Distillate)	0	0	0	0	0	0	10	71	103	1	15	2
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	3	27	47	1	7	1	1	9	15	0	2	0
Other Fuel Combustion (Industrial Residual)	1	3	2	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	3	6	10	0	2	0	1	2	3	0	1	0
Other Fuel Combustion (Residential Residual)	29	68	112	2	17	3	51	120	197	4	30	5
Other Fuel Combustion (Residential Coal)	8	12	25	13	366	0	23	34	69	37	1,020	0
Open Burning (Residential MSW)	4,497	710	118	3,550	10,059	0	2,746	434	72	2,168	6,143	0
Open Burning (Residential Yard Waste)	777	0	0	572	2,289	0	474	0	0	350	1,398	0
Open Burning (Agricultural Fields)	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Ditches)	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Prescribed)	0	0	0	0	0	0	0	0	0	0	0	0
Other Fires (Structural)	8	1	0	9	47	0	5	1	0	5	27	0
Other Fires (Vehicles)	12	0	0	4	15	0	7	0	0	2	9	0
Other Fires (Wildfires)	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Windblown Dust	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Tillage)	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Construction Activities)	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	0	0	0	0	0	0	0	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	9,093	0	0	0	0	0	14,967
Fertilizer Ammonia	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage Ammonia	0	0	0	0	0	1,510	0	0	0	0	0	3,335
Biogenic Emissions	0	941	0	2,374	0	0	0	408	0	3,375	0	0
Gasoline Distribution (Stage I)	0	0	0	4,481	0	0	0	0	0	2,094	0	0
Gasoline Distribution (Stage II)	0	0	0	1,648	0	0	0	0	0	770	0	0
Gasoline Distribution (Underground Tank)	0	0	0	390	0	0	0	0	0	182	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	29	0	0	0	0	0	14	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	2	0	0
Autobody Refinishing	0	0	0	0	0	0	0	0	0	0	0	0
Architectural Surface Coating	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0	0	0	0	0	0
Consumer Solvent Use	0	0	0	6,087	0	0	0	0	0	2,673	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	0	0	0	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	0	0	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and Electrical)	0	0	0	0	0	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	0	0	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Factory Finished Wood)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Wood Furniture)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Machinery and Equipment)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Motor Vehicles)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	0	0	0	0	0	0	0	0	0
Pesticides	0	0	0	0	0	0	0	0	0	0	0	0
Traffic Markings	0	0	0	0	0	0	0	0	0	0	0	0
Asphalt Paving	0	0	0	0	0	0	0	0	0	0	0	0
Charbroiling	323	0	0	0	0	0	142	0	0	0	0	0
Total	**13,010**	**8,536**	**439**	**51,078**	**65,976**	**10,649**	**6,677**	**2,265**	**507**	**23,499**	**32,410**	**18,313**

Note: Open burning emissions were zeroed out for air quality modeling.

4.0 1999 ON-ROAD MOBILE SOURCES

The category of on-road mobile source emissions includes emissions from vehicles certified for highway use – cars, trucks, and motorcycles. Emissions for these vehicles are estimated by combing EPA emission factors from the MOBILE6 and PART5 models, expressed in grams per mile (g/mile), with VMT activity data. For the 1999 annual emissions, these estimates were made for each of Ada and Canyon counties. For the 1999 episodic modeling (December 20-26, 1999), much more detailed modeling was performed using link-level transportation modeling output from COMPASS. This section describes details of the modeling procedures for estimating 1999 annual and episodic on-road emission inventories. Model input files are provided in Appendix B.

Also discussed in this section are the estimates of fugitive dust from paved and unpaved roads in Ada and Canyon counties. These estimates are based on local measurements collected in the Treasure Valley Road Dust Study, conducted in 2001 by the Desert Research Institute (Etymezian et al., 2002).

4.1 COMPASS ACTIVITY DATA

On-road emissions estimates were generated using vehicle miles traveled (VMT) and speed estimates for each roadway in the COMPASS transportation modeling network. The COMPASS transportation networks for Ada and Canyon counties are provided in Figures 4-1a and 4-1b, respectively.

The 1999 model network includes road projects that were completed and open to the motoring public by December 31, 1999. In June 2001COMPASS contracted with CH2MHill to review the 1999 model network for roadway characteristics. The items reviewed were posted speed, number of through lanes, and number of total lanes. CH2MHill reviewed network characteristics and indicated any changes to be made. These changes were made in the appropriate model networks.

Transportation modeling for the 1999 base year uses the latest Census 2000 estimates of population and household demographics.

For annual modeling, VMT was summed by roadway type and county. For the VMT total for each facility type, the average daily VMT for a six-month "summer" (April through September) and a six-month "winter" (January through March and October through December) was calculated based on monthly activity indicators supplied by COMPASS. The "summer" and "winter" emissions were then averaged to obtain the annual average.

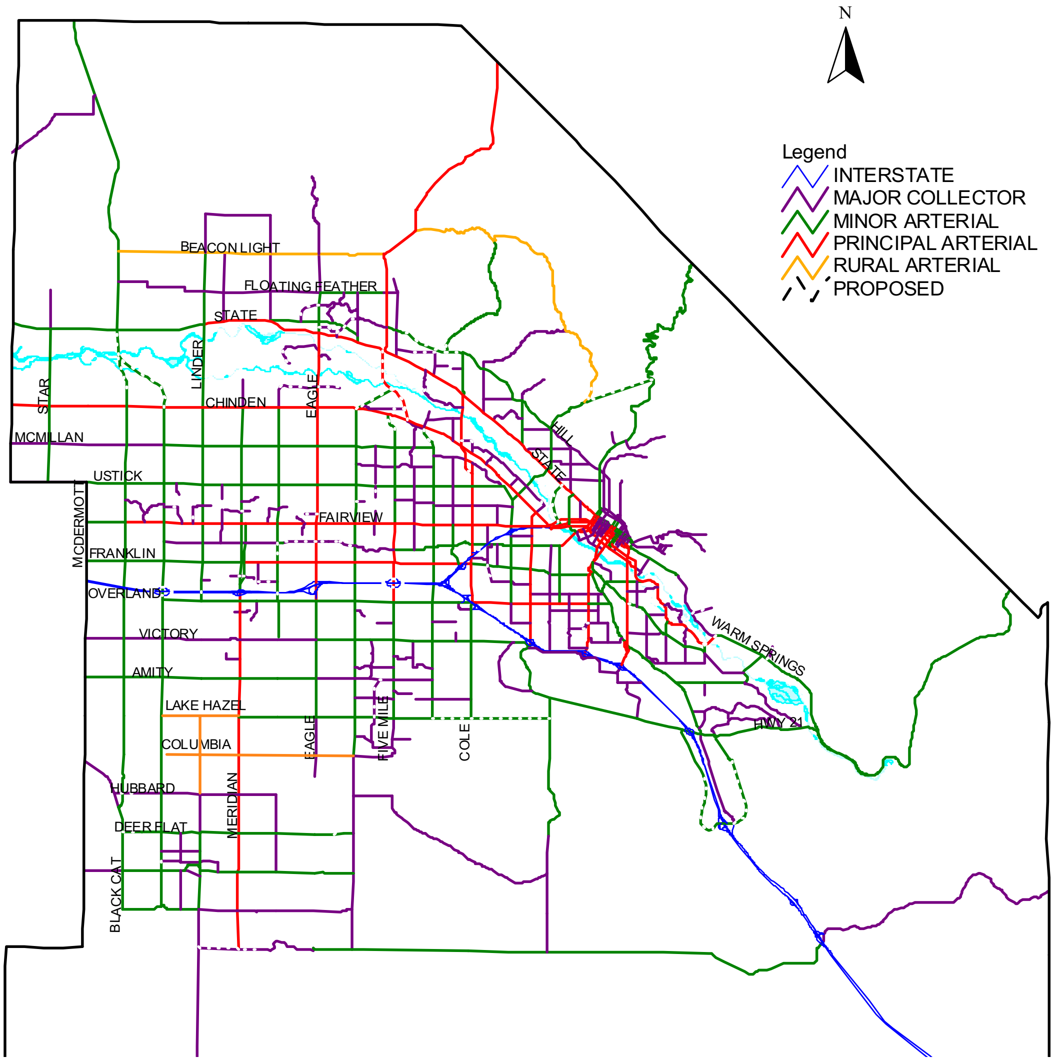

Figure 4-1a. COMPASSS transportation modeling network for Ada County.

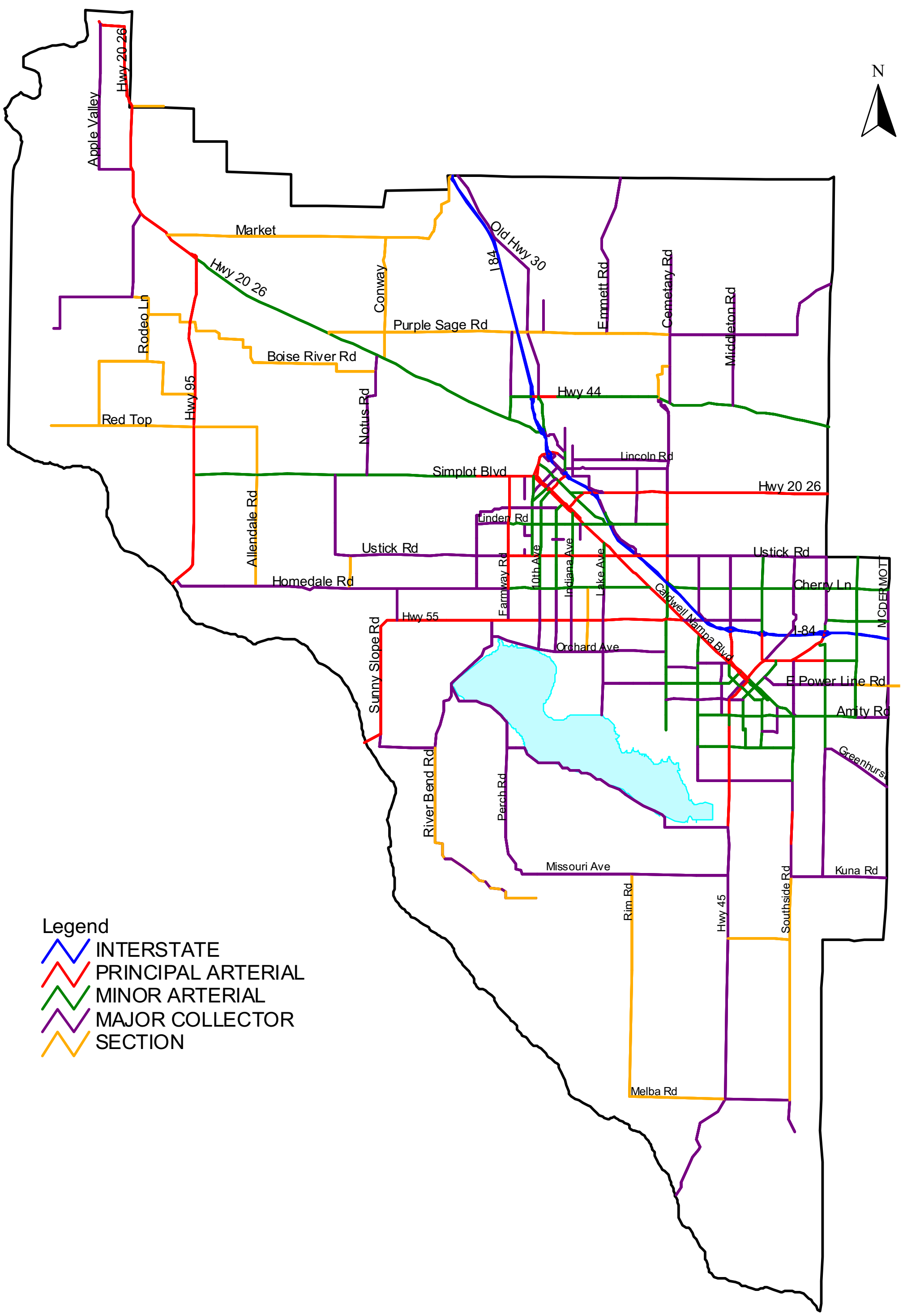

Figure 4-1b. COMPASSS transportation modeling network for Canyon County.

For episodic modeling, emissions were calculated for each link in the COMPASS transportation network. The EXPLORA model (SAI, 1996) was used to merge the MOBILE6 and PART5 emission factors with the COMPASS link-level VMT and speeds. The COMPASS activity data from their transportation model is reported as annual average activity. Adjustments were made for December weekdays and weekends using factors developed by COMPASS (from Idaho Transportation Department traffic counter data) as shown in Table 4-1.

Table 4-1. December VMT weekday/weekend adjustment factors.

	Ada County	Canyon County
December weekday	0.9221	0.9217
December weekend	0.6334	0.7373

4.2 MOBILE6 AND PART5 MODEL INPUTS

4.2.1 Overview of MOBILE6 and PART5 Models

The EPA MOBILE6 and PART5 models estimate emission factors (g/mile) by vehicle class, which are then multiplied by appropriate VMT estimates to estimate on-road vehicular emissions. The MOBILE6 model, released in January 2002, is the latest in a series of MOBILE models for estimating vehicular exhaust VOC and CO, and exhaust and evaporative VOC. When mobile source emissions modeling was first performed for the SIP effort, MOBILE6 was available only in draft form. The initial modeling was conducted using a draft version of the model; when the model was officially released in January 2002, all of the on-road emissions estimates were revised to incorporate the final model release.

The MOBILE6 model includes the effects of all Federal motor vehicle control programs:

- Tier 1 light-duty vehicle standards, beginning with the 1996 model year;
- National Low Emission Vehicle (NLEV) standards for light-duty vehicles, beginning with model year 2001;
- Tier 2 light-duty vehicle standards; beginning with model year 2005;
- Heavy-duty vehicle standards beginning with model year 2004; and
- Heavy-duty vehicle standards (with low sulfur diesel) beginning with model year 2007.

EPA's PART5 model estimates on-road motor vehicle PM and SO_2 emissions. This model is dated, and has not been substantially changed for many years. It is based on very little test data, and does not incorporate results of light-duty and heavy-duty PM emission testing programs conducted in the last several years. PART5 does not incorporate the effects of the 2007 heavy-duty diesel vehicle (HDDV) standards with low sulfur diesel, and so overestimates HDDV PM and SO_2. Nor does it incorporate the effects of the Tier 2 light-duty vehicle and low-sulfur gasoline regulations, and so overestimates light-duty SO_2. In May 2002 EPA released a draft version of MOBILE6.1, which includes PM, SO_2, and NH3 emission factors. The emission factor calculations are based on PART5 (but using

MOBILE6 fleet characterization data); this model includes the effects of the latest Federal regulations but does not update the emission factors with new test data. However, this model was not available in time for use in this study.

Discussions were held with EPA personnel from the Office of Transportation and Air Quality (OTAQ) about updating PART5 to incorporate the latest regulations for use in this SIP modeling. We were told by OTAQ that they would not accept a revised PART5 for SIP modeling, as they did not have staff time to review any such model, and MOBILE6.1 was to come out shortly (Dolce, 2002). The EPA PART5 model was therefore used without any modification, and overestimates emissions as stated above.

4.2.2 MOBILE6 Inputs for Annual Modeling

For the 1999 annual inventory, MOBILE6 was run to generate winter and summer emission factors separately for Ada and Canyon counties. MOBILE6 can model either January 1 or July 1 of each calendar year. For calendar year 1999 emissions, MOBILE6 was set to run July 1, 1999 for summer emission factors, and the average emission factors from runs for January 1, 1999 and January 1, 2000 was used for winter emission factors.

MOBILE6 input files for Ada and Canyon counties are provided in Appendix B. Details of the MOBILE6 inputs used are described below.

Speeds by Facility Type

MOBILE6 models four facility types: freeway, arterial, local, and ramp, each with a unique assumed driving cycle used for emission factor calculation. When modeling a freeway or arterial, the user can specify a speed ranging from 2.5mph to 65mph. However, local and ramp speeds are fixed in MOBILE6, at 12.9 and 34.6mph respectively. The transportation modeling files provided by COMPASS contained activity and speed data for each link in their transportation network. COMPASS identified each link as one of the following roadway types: interstate, principal arterial, minor arterial, collectors, local roads, interstate ramps, and centroid connectors. For the annual modeling, a VMT-weighted average speed by facility class by county was calculated from the COMPASS transportation modeling data.

For local roads and ramps, it is not possible with MOBILE6 to model both the correct facility type (driving cycle) and the proper speeds. There were three options for modeling local roads:

- model as “local” in MOBILE6, losing speed corrections since speed is fixed at 12.9mph;
- model as “arterial” in MOBILE6, retaining varying speeds but losing the local driving cycle.
- model as both “local” and “arterial” in MOBILE6, assuming the local driving cycle with the arterial speed corrections.

The third option was chosen as best representing both driving cycle and speed effects. This assumed that the speed effects in local roads would be comparable to arterials. The equation for determining the local road emission factor is

$$EF_{local} = EF_{M6\text{-}arterial}(S) * EF_{M6\text{-}local}(12.9mph) / EF_{M6\text{-}arterial}(12.9mph)$$

where

$$EF_{local} = \text{actual emission factor used for local roads}$$
$$EF_{M6\text{-}arterial} = \text{MOBILE6 arterial emission factor}$$
$$EF_{M6\text{-}local} = \text{MOBILE6 local emission factor}$$
$$S = \text{speed, mph.}$$

There was no such natural compromise for modeling ramps. The driving cycle on ramps, virtually all rapid acceleration or deceleration, is completely different from either freeway or arterial driving. Furthermore, since ramps contribute only a small portion of total VMT, it was decided to retain the driving cycle and lose the speed effects. Thus ramps were modeled as ramps in MOBILE6, all at one speed and with no other corrections. Table 4-2 summarizes the roadway type assumptions made for modeling purposes, and shows the VMT-weighted average speed calculated and used for each county in the annual modeling.

Table 4-2. Roadway types and speeds used in annual MOBILE6 modeling.

COMPASS Roadway Type	MOBILE6 Roadway Type	VMT-weighted Average Speed (mph) Ada County	Canyon County
Interstate	Freeway	48.8	54.1
Principal Arterial	Arterial	34.9	36.6
Minor Arterial	Arterial	34.3	35.3
Collectors	Arterial	29.9	36.3
Local Roads	Arterial	32.9	36.4
Interstate Ramps	Ramp	30.4	24.7
Centroid Connectors	Arterial	15.1	15.0

All freeway and arterial modeling in MOBILE6 was done for a range of 2.5 to 65mph, at increments of 2.5mph.

Fleet Characterization

Local registration data were unavailable from IDEQ, COMPASS, or ITD; MOBILE6 default registration data were therefore used in the modeling. There was also no local data on the VMT mix (by vehicle class); the MOBILE6 default VMT mix was used.

Temperature and Humidity

National Weather Service (NWS) Boise airport temperatures for 1999 were obtained from the Western Regional Climate Center at http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?idboi7. Minimum, average, and maximum temperatures were calculated from the corresponding monthly averages, with January to March and October to December used for winter modeling, and April to September used for summer modeling.

The absolute humidity input in MOBILE6 can be calculated from relative humidity, pressure, and temperature. The methodology is provided at the using EPA MOBILE6 website (http://www.epa.gov/otaq/m6.htm). Average relative humidity, pressure, and temperature for summer and winter were determined from the NWS Boise Airport data for 1999.

Altitude

Both Ada and Canyon counties were modeled with the low altitude setting in MOBILE6, per instructions from COMPASS and EPA.

Fuel Inputs

Winter gasoline fuel volatility (Reid vapor pressure, RVP) was set at 15.0 psi per instructions from COMPASS and IDEQ. Summer RVP was set to 8.6 psi, the value used in the on-road emissions modeling for Ada and Canyon counties in the Western Regional Air Partnership (WRAP), based on fuel survey data from the American Automobile Manufacturers Association (AAMA, now known as AAM). Neither reformulated gasoline nor oxygenated fuel is in use in the two counties.

Inspection and Maintenance

The Ada County I/M program was modeled as an annual Idle test for all gasoline vehicles with stringency at 27%, compliance at 98%, and waiver rates at 1.5%, and test and repair. These parameters are in accordance with text of Appendix B from the CO Maintenance SIP (IDEQ, 2001). Canyon County does not have an I/M program.

The Anti-Tampering Program (ATP) was modeled in accordance with MOBILE5b input files found in the COMPASS 2002-2006 Air Quality Conformity Demonstration (COMPASS, 2001). Canyon County does not have an ATP.

4.2.3 MOBILE6 Inputs for Episodic Modeling

For episodic air quality modeling, detailed on-road mobile emissions were estimated for each roadway in the COMPASS transportation network shown in Figure 4-1. In order to model the December 20-26, 1999 episode, MOBILE6 was set to run for January 1, 2000.

Emissions were estimated for each link in the COMPASS transportation network using the link-specific VMT and speeds, and the appropriate MOBILE6 emission factor. To do so, MOBILE6 was run at a range of temperatures (20 to 50°F at increments of 5 °F) and speeds (2.5 to 65 in increments of 2.5 mph) for each roadway type (except for ramps, fixed at 34.6 mph). The EXPLORA model (SAI, 1996) was used to match the appropriate emission factor (i.e., for the correct temperature and speed) for each link for each hour of the day; EXPLORA also grids the emissions using the link coordinates. The temperatures for the two day types in the 1999 episode have been provided in Figure 1-1. Figure 4-2 shows the factors used to allocate the average daily emissions to each hour of the day; these were provided by COMPASS from an analysis of traffic counter data.

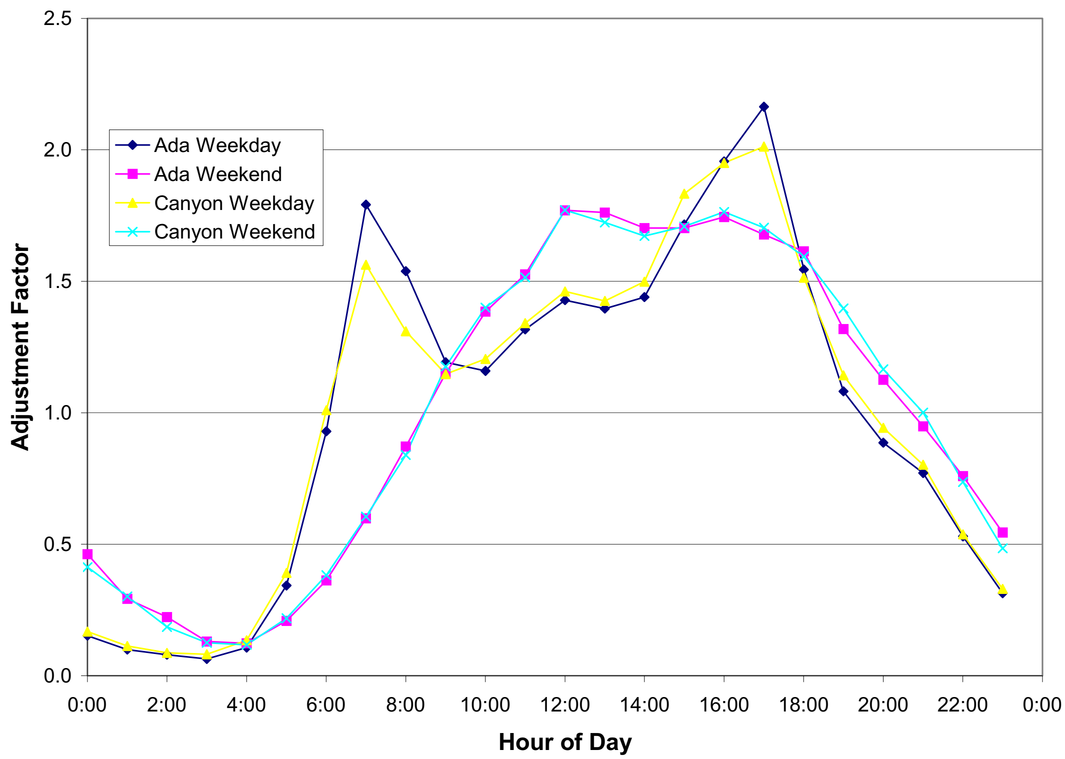

Figure 4-2. Diurnal traffic variation in Ada and Canyon Counties.

4.2.4 PART5 Inputs for Annual and Episodic Modeling

PART5 inputs were based on input files found in the PM_{10} Air Quality Conformity Demonstration for 2002-2006 (COMPASS, 20010).

The inputs to the PART5 model are the same as the MOBILE6 inputs described above, except:

- The I/M flag is less specific; it merely indicates the presence or absence of an I/M program. The I/M flag was set for Ada County and not set for Canyon County.
- MOBILE6 default VMT mix, mileage accumulation rates, and registration data equivalents were used in the PART5 modeling. Because the number of vehicle types in MOBILE6 and PART5 are different, appropriate adjustments were made to accommodate the data.

PART5 was run at each of the calculated facility-specific VMT-weighted speeds shown in Table 4-1. The resulting emission factors were applied to the appropriate VMT values to obtain an annual emission inventory estimate. PART5 has only one time of year setting; the model was run for January 1, 2000 to estimate 1999 annual emissions.

4.3 EMISSIONS BY VEHICLE CLASS AND ROADWAY TYPE

Table 4-3 shows the 1999 average daily emissions by vehicle class, season, and pollutant. The relative emissions contribution of each vehicle class to the combined Ada and Canyon counties emissions for an average winter day in 1999 is shown in Figure 4-3. The majority of VOC, CO, SO_X, and NH3 emissions are from light-duty vehicles; heavy-duty vehicles comprise about half of the on-road NO_x and PM_{10} emissions.

Table 4-4 shows the 1999 average daily emissions by MOBILE6 facility class, season, and pollutant. (The totals in Tables 4-3 and 4-4 do not match exactly because of the number of significant digits for the emission factors from MOBILE6 and PART5.) The relative emissions contribution of each facility class to the combined Ada and Canyon counties emissions for an average winter day in 1999 is shown in Figure 4-4. As expected, the relative contribution by facility class is about the same for all pollutants. Interstates account for about 25 percent of the on-road emissions, arterials account for about 50 percent of the emissions, and collectors and connectors account for the approximate remaining 25 percent.

Table 4-3. 1999 Average winter day, average summer day, and annual on-road emissions by vehicle class.

		Ada County						Canyon County						Ada & Canyon Counties					
Season	**Vehicle Type**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**	**NH3**
Summer (TPD)	LDGV	4.26	4.61	49.89	0.18	0.27	0.18	1.96	2.10	34.64	0.07	0.11	0.07	6.22	6.71	84.53	0.25	0.38	0.25
	LDGT12	2.54	2.60	36.06	0.12	0.20	0.10	1.20	1.31	24.08	0.05	0.08	0.04	3.74	3.91	60.14	0.16	0.28	0.14
	LDGT34	1.41	1.17	16.20	0.05	0.07	0.03	0.65	0.58	11.76	0.02	0.03	0.01	2.06	1.75	27.96	0.06	0.10	0.05
	HDGV	0.40	1.22	5.19	0.03	0.04	0.01	0.16	0.51	2.50	0.01	0.02	0.01	0.56	1.74	7.69	0.05	0.06	0.02
	LDDV	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.00	0.00
	LDDT	0.02	0.02	0.03	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.02	0.03	0.03	0.00	0.00	0.00
	HDDV	0.40	8.92	1.91	0.37	0.24	0.03	0.15	3.57	0.71	0.15	0.09	0.01	0.55	12.49	2.61	0.52	0.33	0.04
	MC	0.07	0.06	0.44	0.00	0.00	0.00	0.03	0.03	0.19	0.00	0.00	0.00	0.10	0.09	0.63	0.00	0.00	0.00
	Total On-road	9.10	18.62	109.73	0.75	0.82	0.36	4.16	8.11	73.89	0.30	0.32	0.14	13.26	26.74	183.62	1.05	1.15	0.51
Winter (TPD)	LDGV	4.57	5.07	71.78	0.17	0.27	0.18	2.10	2.07	34.28	0.07	0.11	0.07	6.67	7.14	106.06	0.24	0.37	0.25
	LDGT12	2.91	3.12	52.44	0.12	0.20	0.10	1.39	1.35	24.98	0.05	0.08	0.04	4.30	4.47	77.43	0.17	0.28	0.14
	LDGT34	1.56	1.39	22.41	0.05	0.07	0.03	0.73	0.59	12.08	0.02	0.03	0.01	2.29	1.98	34.49	0.06	0.10	0.05
	HDGV	0.36	1.24	5.30	0.03	0.04	0.01	0.15	0.51	2.48	0.01	0.02	0.01	0.52	1.75	7.78	0.05	0.06	0.02
	LDDV	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.00	0.00
	LDDT	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.00	0.00
	HDDV	0.38	8.64	1.83	0.37	0.24	0.03	0.14	3.57	0.70	0.15	0.09	0.01	0.53	12.21	2.53	0.52	0.33	0.04
	MC	0.07	0.07	0.48	0.00	0.00	0.00	0.03	0.03	0.18	0.00	0.00	0.00	0.10	0.10	0.67	0.00	0.00	0.00
	Total On-road	9.87	19.56	154.27	0.75	0.82	0.36	4.56	8.12	74.72	0.30	0.32	0.14	14.43	27.69	228.99	1.05	1.15	0.50
Annual (TPY)	LDGV	1611	1767	22205	64	99	66	741	762	12578	25	39	26	2352	2528	34782	89	137	92
	LDGT12	994	1045	16151	43	73	37	474	485	8955	17	29	15	1468	1530	25106	60	102	51
	LDGT34	542	468	7047	17	25	13	252	213	4351	7	10	5	794	680	11398	23	36	18
	HDGV	139	450	1915	13	16	5	58	186	909	5	6	2	196	636	2824	17	22	7
	LDDV	2	5	5	1	0	0	1	2	2	0	0	0	3	7	7	1	0	0
	LDDT	5	7	8	1	1	0	2	3	2	0	0	0	6	9	10	1	1	0
	HDDV	142	3205	681	135	86	11	53	1303	257	53	34	4	196	4508	939	189	120	15
	MC	26	23	169	1	0	1	10	10	68	0	0	0	36	34	238	1	1	1
	Total On-road	3462	6969	48180	274	300	132	1590	2963	27123	108	118	52	5052	9932	75303	382	418	184

LDGV = Light-duty gasoline vehicle
LDGT12 = Light-duty gasoline truck class 1 and 2
LDGT34 = Light-duty gasoline truck class 3 and 4
HDGV = Heavy-duty gasoline vehicle
LDDV = Light-duty diesel vehicle
LDDT = Light-duty diesel truck
HDDV = Heavy-duty diesel vehicle
MC = Motorcycle

Table 4-4. 1999 Average winter day, average summer day, and annual on-road emissions by MOBILE6 facility class.

		Ada County						Canyon County						Ada & Canyon Counties					
Season	**Source Category**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**	**NH3**
Summer (TPD)	Centroid Connector	1.01	1.58	9.74	0.06	0.06	0.03	0.52	0.74	7.13	0.03	0.03	0.01	1.53	2.32	16.88	0.08	0.09	0.04
	Collectors	0.90	1.70	10.28	0.07	0.08	0.04	0.55	1.02	9.77	0.04	0.04	0.02	1.46	2.72	20.05	0.11	0.12	0.05
	Interstate	2.01	5.35	28.70	0.19	0.20	0.09	1.05	2.74	22.83	0.08	0.09	0.04	3.06	8.09	51.54	0.27	0.30	0.13
	Interstate ramps	0.06	0.10	0.91	0.00	0.00	0.00	0.03	0.04	0.59	0.00	0.00	0.00	0.08	0.14	1.50	0.01	0.01	0.00
	Local roads	0.13	0.21	1.30	0.01	0.01	0.01	0.12	0.18	1.42	0.01	0.01	0.00	0.25	0.39	2.72	0.02	0.02	0.01
	Minor Arterials	2.31	4.54	27.57	0.20	0.22	0.09	0.82	1.49	14.25	0.06	0.06	0.03	3.13	6.03	41.82	0.25	0.28	0.12
	Principal Arterials	2.61	5.15	31.25	0.22	0.24	0.11	1.03	1.89	18.20	0.07	0.08	0.04	3.64	7.04	49.45	0.30	0.33	0.14
	Total On-road	9.02	18.63	109.75	0.75	0.83	0.36	4.13	8.11	74.21	0.29	0.32	0.14	13.15	26.74	183.96	1.04	1.15	0.51
Winter (TPD)	Centroid Connector	1.05	1.66	13.38	0.06	0.06	0.03	0.55	0.74	7.13	0.03	0.03	0.01	1.60	2.41	20.51	0.08	0.09	0.04
	Collectors	0.98	1.79	14.50	0.07	0.08	0.04	0.61	1.02	9.77	0.04	0.04	0.02	1.58	2.81	24.27	0.11	0.12	0.05
	Interstate	2.23	5.56	40.22	0.19	0.20	0.09	1.18	2.74	22.83	0.08	0.09	0.04	3.41	8.30	63.05	0.27	0.30	0.13
	Interstate ramps	0.06	0.10	1.25	0.00	0.00	0.00	0.03	0.04	0.59	0.00	0.00	0.00	0.09	0.15	1.85	0.01	0.01	0.00
	Local roads	0.14	0.22	1.85	0.01	0.01	0.01	0.13	0.19	1.95	0.01	0.01	0.00	0.27	0.42	3.80	0.02	0.02	0.01
	Minor Arterials	2.51	4.79	38.94	0.20	0.22	0.09	0.90	1.49	14.25	0.06	0.06	0.03	3.41	6.28	53.20	0.25	0.28	0.12
	Principal Arterials	2.83	5.43	44.16	0.22	0.24	0.11	1.13	1.89	18.20	0.07	0.08	0.04	3.96	7.32	62.36	0.30	0.33	0.14
	Total On-road	9.80	19.57	154.30	0.75	0.83	0.36	4.53	8.12	74.74	0.29	0.32	0.14	14.33	27.69	229.04	1.04	1.15	0.50
Annual (TPY)	Centroid Connector	376	592	4220	21	23	10	196	272	2604	9	10	4	572	863	6824	30	34	15
	Collectors	343	638	4521	27	29	13	212	372	3568	15	16	7	555	1010	8089	41	45	20
	Interstate	773	1991	12578	68	74	33	408	1001	8334	31	34	15	1181	2992	20912	98	108	48
	Interstate ramps	22	37	395	2	2	1	11	16	216	1	1	0	33	53	611	2	2	1
	Local roads	48	79	574	4	4	2	47	69	616	3	4	2	95	148	1189	8	8	4
	Minor Arterials	879	1704	12138	71	79	35	313	543	5202	22	24	10	1193	2247	17341	93	102	45
	Principal Arterials	993	1930	13762	81	89	39	394	692	6644	27	30	13	1387	2622	20406	108	119	52
	Total On-road	3435	6971	48188	274	301	132	1580	2964	27184	108	118	52	5016	9934	75372	381	420	184

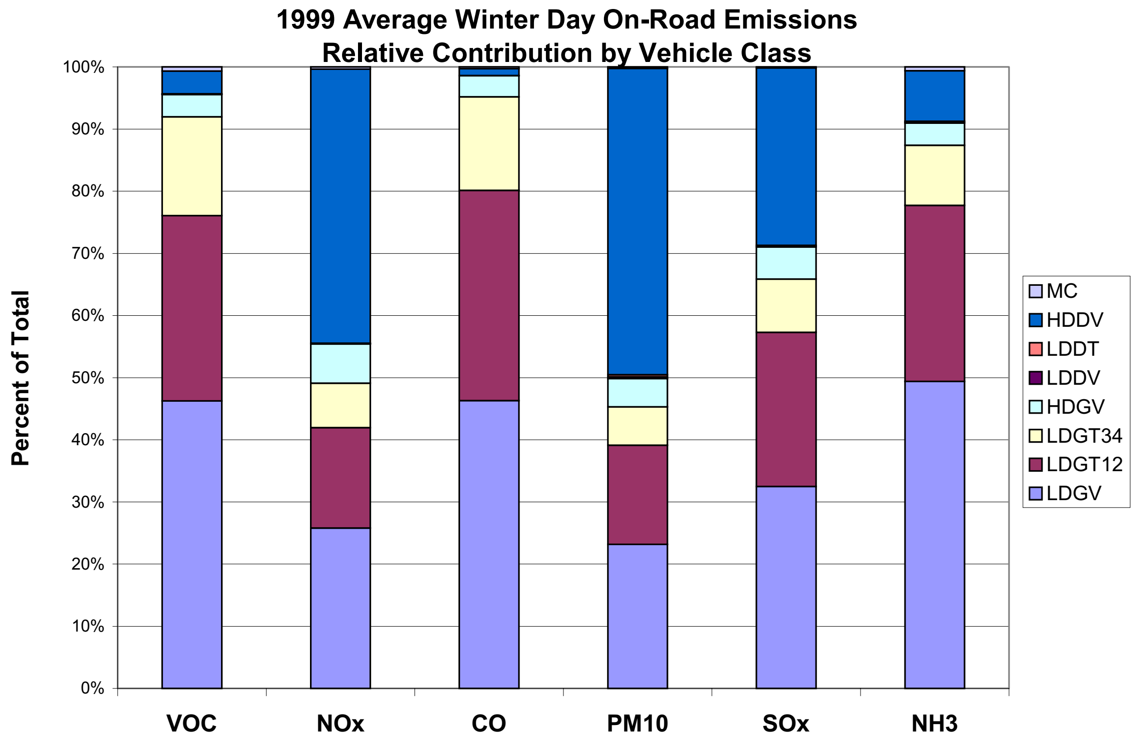

Figure 4-3. Contribution to 1999 average winter day on-road emissions by vehicle class (Ada & Canyon counties).

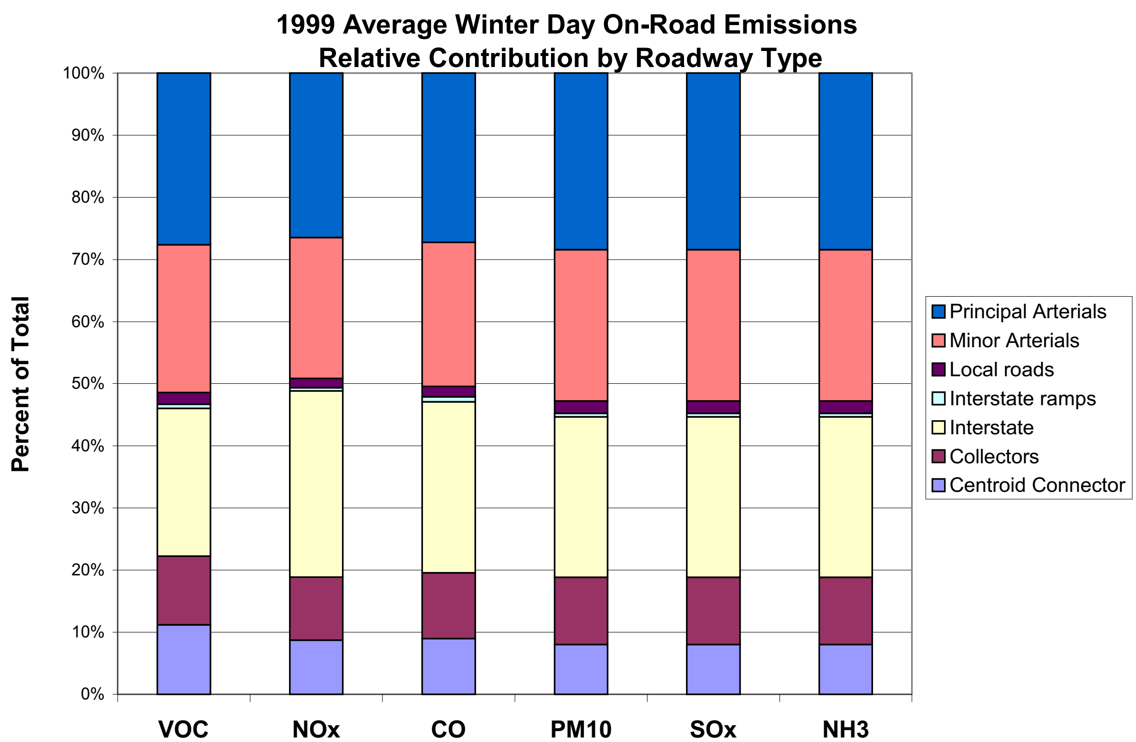

Figure 4-4. Contribution to 1999 average winter day on-road emissions by MOBILE6 facility class (Ada & Canyon counties).

4.4 FUGITIVE ROAD DUST EMISSIONS

Fugitive dust from paved and unpaved roads was estimated using local data from the Treasure Valley Road Dust Study (TVRDS), conducted in 2001 by the Desert Research Institute; a complete and detailed description of the study and study results is provided in the DRI report (Etymezian et al., 2002). The TVRDS provided paved and unpaved fugitive road dust PM_0 and $PM_{2.5}$ emissions annual and episodic emissions for the all modeling years. The field study was divided into a winter portion (2/21/01-3/17/01) and a summer portion (7/10/01-7/24/01). The TRAKER, a vehicle-based device for real-time measurement of dust emissions from roads, was used extensively as part of the study. The field campaign included measurements of silt loadings on Treasure Valley roads, TRAKER street surveys, multiple measurements on a set of roads (TRAKER loop), and two controlled experiments that were coordinated with personnel at the Ada County Highway District (ACHD).

Street surveys conducted with the TRAKER, totaling 430 km each in winter and summer, were the basis for spatial analysis of road dust emissions. For paved roads, the potential for roads to emit dust was found to vary by county, season, and setting (urban or rural). However, the dust emissions potential was most sensitive to the speed of vehicles that travel on the road. Roads associated with higher speeds were substantially cleaner, in terms of the potential to emit road dust, than those associated with lower speeds. Emissions from unpaved roads are 17 times higher than emissions from paved roads (for vehicles traveling at the same speed).

The TRAKER loop data combined with meteorological observations showed that precipitation has a multiple-day effect on unpaved roads. On the day of precipitation, emissions were reduced to 8 percent of the equivalent value for the road under dry conditions. On the day following precipitation, emissions were at 35 percent of those for the dry road. On subsequent days, emissions returned to the dry road value. These values were used to estimate emissions on modeling episode days with precipitation.

The COMPASS year 2000 transportation networks were used in conjunction with TRAKER street surveys to estimate the road dust emissions inventory for the Treasure Valley. Unpaved road locations were not available in electronic format for either Ada or Canyon Counties. An approximation of the spatial distribution of unpaved road emissions was therefore developed as follows. The emissions from unpaved roads were distributed over the transportation modeling network by county and by setting (urban vs. rural). Centroid connectors, interstates, and local roads were assigned zero unpaved road dust emissions. For the remainder of the links (collectors, minor arterials, and principal arterials) for each county and setting, the unpaved road emissions were attributed equally to the links based on the length of the link. For example, rural Ada unpaved emissions were attributed to the links in rural Ada County (not including centroid connectors, interstates, and locals). If link “A” was twice a s long as link “B”, then the unpaved road dust emissions attributed to link “A” were twice as high as those attributed to link “B”.

Table 4-5 shows the annual 1999 road dust emissions for paved and unpaved roads. For the episodic emission inventories for modeling, the average winter day emissions were adjusted for December weekday and weekend activity, using the adjustment factors shown in Table 4-1.

Table 4-5. 1999 annual fugitive road dust emissions (tons).

	Ada	Canyon	Ada & Canyon
Paved roads	18,683	6,276	24,959
Unpaved roads	623	393	1,015
Total	19,306	6,669	25,975

DRI also estimated fugitive road dust emissions using the standard EPA AP-42 method with silt loadings measured on-site in the Treasure Valley. The emissions shown in Table 4-5 are higher than emissions calculated using the AP-42 method. Details of those calculations and comparisons can be found in Section 5 of the DRI report (Etymezian et al., 2002).

4.5 DATA MANAGEMENT AND QUALITY ASSURANCE/QUALITY CONTROL

In general, procedures described in *Final Inventory Preparation Plan/Quality Assurance Plan (IPP/QAP)* (ENVIRON, 2001) were used to check, and correct when necessary, the on-road mobile sources emissions estimates. All MOBILE6 and PART5 input and output files, and Excel spreadsheets used to calculate the emissions, were checked by personnel who were not involved in the development of the modeling inputs/outputs and spreadsheets. Fugitive road dust emissions were checked by comparing totals in the DRI spreadsheets to the output of the EXPLORA model. In addition, the emissions estimates were reviewed for reasonableness by IDEQ staff and external stakeholders.

5.0 1999 OFF-ROAD MOBILE SOURCES

Off-road mobile sources encompasses a wide variety of equipment types that either move under their own power or are capable of being moved from site to site. Off-road mobile equipment sources, not licensed or certified as highway vehicles, are defined as those that move or are moved within a 12 month period and are covered under the EPA's emissions regulations as nonroad mobile sources.

EPA's NONROAD model was used to estimate emissions for most off-road sources.The NONROAD model estimates emissions from nonroad equipment in the following categories:

- agricultural equipment, such as tractors, combines, and balers;
- airport ground support, such as terminal tractors;
- construction equipment, such as graders and back hoes;
- industrial and commercial equipment, such as fork lifts and sweepers;
- recreational vehicles, such as all-terrain vehicles and off-road motorcycles;
- residential and commercial lawn and garden equipment, such as leaf and snow blowers;
- logging equipment, such as shredders and large chain saws;
- recreational equipment, such as off-road motorbikes and snowmobiles; and
- recreational marine vessels, such as power boats.

Aircraft and locomotive emissions are also included in the non-road inventory, but are not estimated in the NONROAD model. EPA methodologies were used to estimate emissions for these two categories.

This section discusses in detail the methodology for estimating 1999 base year off-road mobile source emission inventories, and provides tabular summaries of future year off-road emission inventories by off-road source category.

5.1 INVENTORY METHODOLOGY

5.1.1 EPA NONROAD Modeling

The EPA draft NONROAD model was used to estimate emissions for all off-road mobile source categories except locomotive and aircraft. This model has been under development by EPA for many years, and EPA has periodically released updated draft versions of the model. The draft version most recently publicly released by EPA is the June 2000 version, available on the NONROAD model web site at http://www.epa.gov/oms/nonrdmdl.htm; this version of the model was used for the Boise area modeling. The NONROAD web site also includes extensive technical documentation for the model and a User's Guide. A brief description of the model can be found in Pollack and Lindhjem (1997). Although the NONROAD model is in draft form and is still evolving, it has been used to develop the EPA's 1999 National Emissions Inventory (NEI99) and also in recent SIP modeling efforts that have been accepted by EPA.

The NONROAD model estimates emissions for six exhaust pollutants: VOC, NO_X, CO, CO_2, SO_X, and PM (both PM_{10} and PM2.5). The model also estimates emissions of non-exhaust HC for six modes — hot soak, diurnal, refueling, resting loss, running loss, and crankcase emissions.
The model provides emission estimates at the national, state, and county level. County level emissions are determined by allocating the state level estimates with econometric or other activity indicators, such as employees, tilled acreage, and construction valuation. The NONROAD model also provides monthly or average annual day (for weekdays or weekend days) emission estimates.

The NONROAD model incorporates the effects of the emission standards through a dynamic age distribution calculation. The national non-road emission standards included in the model are:

- Diesel engines
- Small gasoline engines (handheld and nonhandheld equipment < 25 hp)
- Recreational marine gasoline engines
- Recreational and commercial marine diesel engines

The model includes more than 80 basic and 260 specific types of nonroad equipment, and further stratifies equipment types by horsepower rating and fuel type. The basic equation for estimating emissions in the NONROAD model is as follows:

$$Emissions = (Pop)*(Power)*(LF)*(A)*(EF)$$

where

Pop = Engine Population
Power = Average Power (hp)
LF = Load Factor (fraction of available power)
A = Activity (hrs/yr)
EF = Emission Factor (g/hp-hr)

The national or state engine population is estimated and multiplied by the average power, activity, and emission factors. National average engine power, load factor (the relative fraction of maximum available power that engine use on average), annual activity, and emission factors are estimated and used to calculate the national yearly emissions. Equipment population by county is estimated in the model by geographically allocating national engine population through the use of econometric indicators, such as construction valuation. The manner in which the geographic allocation is performed is as follows:

$$(County\ Population)_i / (National\ Population)_I = (County\ Indicator)_i / (National\ Indicator)_i$$

where

i is an equipment application like construction or agriculture.

Activity is temporally allocated using an analogous equation but using monthly and day of week fractions of yearly activity.

The NONROAD model has default estimates for all variables and factors used in the calculations. All of these estimates are in model input files, and can be changed by the user if data more appropriate to the local area are available. The following sub-sections describe modifications to NONROAD model inputs.

5.1.1.1 NONROAD Model Inputs

The NONROAD model requires specification of several inputs. Fuel RVP and sulfur levels were the same as those used in the 1999 on-road mobile source MOBILE6 and PART5 modeling as described in Section 4.2. Temperature were also the same as used in the MOBILE6 and PART5 modeling as described in Section 4.2 – episodic temperatures (shown in Figure 1-1) for the December 1999 episode, and National Weather Service (NWS) 1999 Boise airport temperatures for the annual modeling.

While the model includes default assumptions for all emissions calculations, EPA encourages air quality planning agencies to substitute into the model local data where available. For this emission inventory modeling effort, some improved and/or local data sources were identified. Modifications to the default modeling approach were made for four source categories as described below.

Additional adjustments were made to the NONROAD default equipment populations. Logging emissions were estimated for the Boise area, because the population geographic allocation factor is number of employees in lumber and wood products industries, and Boise Cascade is headquarted in Boise. Since there is no longer any logging in the area, logging equipment populations were zeroed out. Snowmobile and snowblower populations allocated by the model to Boise and Canyon counties were zeroed out for both the annual and episodic 1999 emission inventories because of very low snow levels (in particular, there was no snow on the ground during the December episode).

5.1.1.2 Agricultural Equipment Population

County-specific agricultural equipment populations for Ada and Canyon counties were obtained from the 1997 Census of Agriculture (USDA, 1999). Equipment populations were available for the following equipment types: tractors, combines, balers, and swathers. The populations were not provided by fuel type; thus, the NONROAD default distribution of equipment by fuel type was assumed for the Census of Agriculture data. Agricultural equipment types included in the NONROAD model defaults but not in the Census of Agriculture data were left unchanged.

The current draft version of the NONROAD model does not accommodate county-level population inputs; only state-level populations with county allocations are allowed. Thus, several steps were taken to be able to use the Census of Agriculture county populations. First, county-level populations were calculated for all NONROAD default equipment types using the NONROAD default agricultural equipment allocation for Ada and Canyon counties. Where available, Census of Agriculture county populations replaced default data. The final county populations were entered into a NONROAD population file as Idaho State total populations.

Then a non-default allocation file was created for each county that allocated the entire state population to the applicable county.

5.1.1.3 Construction Equipment Population

In the current draft NONROAD model, construction equipment is allocated using Dodge 1997 total construction valuation by county. F.W. Dodge, a subsidiary of McGraw-Hill, determines construction activity from permit issuing places, government sources, and over 3,000 local newspapers and other publications, although permits are the primary source of their information concerning construction valuation.

The current NONROAD model allocates construction based on total construction dollars. The improved method takes the construction project type into account and thus weights the dollar amounts by the activity associated with them. For example, single-family home construction alone accounts for almost 40 percent of total construction costs, and so also dominates the construction equipment allocation in the current draft of the NONROAD model. However, construction valuation is not necessarily a direct measure of construction equipment activity because of the nature of the work (e.g., only certain project types require earth-moving equipment), or because some value-added construction activity, such as carpentry and electrical work, does not require fuel-powered equipment. In particular, single-family home construction, though high in percent of total construction valuation, will likely not have been responsible for as high a fraction of construction equipment activity. Conversely, road and bridge construction account for a much larger portion of heavy construction activity per permit dollar. Survey results from a construction equipment survey performed in Houston in 1998 (Pollack et al., 1999) were used to develop a construction allocation indicator which is better correlated with construction activity.

The allocation factor for each county (j) is applied to the NONROAD national total population:

$$\text{Allocation Factor}_j = \frac{(SFH_j + 3*OBLDG_j + 18.4*R\&B_j + 8.5*PW_j)}{(SFH + 3*OBLDG + 18.4*R\&B + 8.5*PW)}$$

where the variables are the dollar valuation for either the county (j) or national total

SFH for single/double-family housing construction,
OBLDG for other building construction,
R&B for road and bridge construction, and
PW is public works (sewer, water, and drainage) construction.

5.1.1.4 Ground Support Equipment (GSE) Population

Boise Air Terminal ground support equipment populations for 1995 were taken from the previous Boise area emission inventory work (SAI, 1997). ENVIRON was unable to obtain updated 1999 information on landings and take-offs (LTOs) and GSE populations for the Boise Air Terminal. Thus, the 1995 GSE populations were grown to 1999 using the growth in Boise Air Terminal LTOs from 1995 to 1999 available from the Federal Aviation Administration (FAA) (available at http://www.apo.data.faa.gov/faatafall.HTM). Updated information on horsepower (HP) rating, load, and usage for 21 specific GSE types was obtained from a California Air Resources Board (CARB) report (EEA, 1994). Table 5-1 shows the estimated 1999 GSE equipment populations for the 21 CARB types, along with the CARB information on horsepower (HP) rating, load, and usage.

Table 5-1. Boise Air Terminal 1999 GSE populations and activity.

Code	Equipment	Fuel	HP	Load Factor	Usage (hrs/year)	Population
ACU	AC Unit	Diesel	300	0.75	21.9	5.48
ASU	Air Start Unit	Diesel	370	0.90	135.1	4.33
ACT	Aircraft Tug	Diesel	175	0.80	551.2	6.56
BGT	Baggage Tug	Diesel	78	0.55	876.0	6.01
BLD	Belt Loader	Diesel	45	0.50	810.3	8.20
BUS	Bus	Diesel	180	0.25	1945.5	1.08
CLD	Cargo Loader	Diesel	76	0.50	719.1	1.08
CRT	Cart	Diesel	50	0.50	182.5	2.16
DCR	Deicer	Diesel	93	0.95	21.9	2.26
FKL	Forklift	Diesel	52	0.30	726.4	0
FTR	Fuel Truck	Diesel	180	0.25	1080.4	6.49
GPU	GPU	Diesel	145	0.75	795.7	14.07
LCT	Lav Cart	Diesel	nd	nd	nd	0
LTR	Lav Truck	Diesel	130	0.50	449.0	1.08
LFT	Lift	Diesel	nd	nd	nd	0
MTR	Maint. Truck	Diesel	130	0.50	449	7.63
OTH	Other	Diesel	50	0.50	182.5	15.15
PKP	Pickup	Diesel	nd	nd	nd	0
STR	Service Truck	Diesel	170	0.20	1299.4	0.35
VAN	Van	Diesel	nd	nd	nd	0
WTR	Water Truck	Diesel	nd	nd	nd	0
ACU	AC Unit	Gasoline	130	0.80	21.9	2.09
ASU	Air Start Unit	Gasoline	130	0.90	135.1	2.16
ACT	Aircraft Tug	Gasoline	130	0.80	551.2	6.22
BGT	Baggage Tug	Gasoline	100	0.55	876.0	34.65
BLD	Belt Loader	Gasoline	60	0.50	810.3	18.55
BUS	Bus	Gasoline	130	0.25	1945.5	2.16
CLD	Cargo Loader	Gasoline	70	0.50	719.1	1.08
CRT	Cart	Gasoline	12	0.50	149.7	26.21
DCR	Deicer	Gasoline	93	0.95	21.9	13.97
FKL	Forklift	Gasoline	50	0.30	726.4	2.16
FTR	Fuel Truck	Gasoline	130	0.25	1080.4	10.82
GPU	GPU	Gasoline	150	0.75	795.7	8.66
LCT	Lav Cart	Gasoline	12	0.50	182.5	1.08
LTR	Lav Truck	Gasoline	130	0.25	1211.8	1.08
LFT	Lift	Gasoline	100	0.50	376.0	2.16
MTR	Maint. Truck	Gasoline	130	0.50	449.0	23.70
OTH	Other	Gasoline	50	0.50	182.5	4.33
PKP	Pickup	Gasoline	130	0.25	529.3	39.97
STR	Service Truck	Gasoline	180	0.20	1299.4	3.92
VAN	Van	Gasoline	130	0.25	310.3	18.39
WTR	Water Truck	Gasoline	150	0.20	310.3	1.08
ACU	AC Unit	LPG	300	0.75	21.9	0

Code	Equipment	Fuel	HP	Load Factor	Usage (hrs/year)	Population
ASU	Air Start Unit	LPG	nd	nd	0	0
ACT	Aircraft Tug	LPG	130	0.80	551.2	0.20
BGT	Baggage Tug	LPG	100	0.55	876.0	0.45
BLD	Belt Loader	LPG	60	0.50	810.3	0.31
BUS	Bus	LPG	nd	nd	0	0
CLD	Cargo Loader	LPG	70	0.50	719.1	0
CRT	Cart	LPG	25	0.50	149.7	0.92
DCR	Deicer	LPG	nd	nd	0	0
FKL	Forklift	LPG	52	0.30	726.4	4.33
FTR	Fuel Truck	LPG	130	0.25	1080.4	0
GPU	GPU	LPG	nd	nd	0	0
LCT	Lav Cart	LPG	nd	nd	0	0
LTR	Lav Truck	LPG	nd	nd	0	0
LFT	Lift	LPG	100	0.50	376.0	0
MTR	Maint. Truck	LPG	130	0.50	449.0	0.05
OTH	Other	LPG	50	0.50	182.5	0
PKP	Pickup	LPG	130	0.25	529.3	0.06
STR	Service Truck	LPG	180	0.20	1299.4	0.06
VAN	Van	LPG	nd	nd	0	0
WTR	Water Truck	LPG	nd	nd	0	0

The current version of the NONROAD model accepts only one Source Classification Code (SCC) for each GSE for each fuel type (a total of 3 SCCs per equipment type for 4-stroke gasoline, diesel, and LPG-powered GSE). Thus, it was impossible to include all the equipment-specific activity information in one run with the current model version. In order to effectively use all the available data, a separate run was performed for each of the 21 GSE equipment types, with non-default population and activity files for each run. Also, a new allocation file was supplied to the model, instructing it to allocate the entire non-default population to Ada County.

5.1.1.5 Recreational Marine Population

Idaho state and county total boat registrations for 1999 were obtained from the Idaho State Parks and Recreational Department. These data were not broken down by either fuel or specific equipment type. The state boat registration count was assumed to be the state total recreational marine equipment population. The delineations by fuel, equipment, and horsepower were based on the default NONROAD data.

Although county-level registration data were available, it was deemed not useful for county allocation purposes. Idaho allows people to register their boats in up to two counties. The available data for each county indicated only the sum of the primary and secondary registration counties. Thus, populations in any given county could be double-counted. Furthermore, it was deemed that the current EPA NONROAD allocation method, which uses water surface area, is a better indication of actual usage in each area.

One potential source of double-counting could not be eliminated in this case. The Idaho State Parks and Recreational Department makes no distinction in its registrations for boats that are completely non-motorized (sailboats with no on-board engines). Although these boats do not contribute to emissions, there was no way to determine the fraction of the registered boats that fit this category. However, it was assumed that such sailboats comprise a negligible portion of the recreation marine population.

5.1.1.6 Ammonia

The NONROAD model does not estimate ammonia emissions. Gasoline (non-catalyst) and diesel ammonia emissions factors were those used in EPA's recent 1986-1999emission inventory trends estimates (EPA, 2001) based on fuel consumption. All 2-stroke, 4-stroke, CNG, and LPG equipment were assumed to emit ammonia at the gasoline rate.

5.1.2 Locomotives

The locomotive source category includes engine exhaust emissions associated with freight and line-haul and switching locomotive activity. Emissions from locomotive activity in Idaho for the base year 1999 were derived from published emission factors and fuel consumption data relevant to the industry, and were assumed to be constant throughout the year. The activity (fuel consumed) of locomotives was derived from generally accepted national fuel consumption estimates (AAR, 2000) allocated to the state of Idaho throughpublicly-available relative state fuel consumption estimates (EIA, 2000). These state fuel consumption estimates were then allocated to Idaho counties through the use of an estimate of relative activity of freight transfers (ton-mile) within each county. The locomotive emissions in each county were then estimated by applying the EPA averaged emission factors.

The EPA's Office of Transportation and Air Quality (OTAQ) has published HC, CO, NOx and PM pollutants emission factors for locomotives (EPA, 1997). These emission factors are available separately for line-haul and switch locomotive duty cycles, and are also reported as fleet average emission factors. The fleet-average emission factors were weighted based on national line-haul and switch engine fuel consumption data gathered by the Association of American Railroads (AAR, 2000), and were the emission factors applied in estimating emissions in this work.

All PM emissions were assumed to fall below the 10-micron cutoff of particle size fraction and 92% in the $PM_{2.5}$ particle size fraction according to EPA NONROAD documentation. This is consistent with the method applied in the EPA 1999 National Emissions Inventory (EPA, 1998a) to estimate particulate emissions from locomotives.

Sulfur dioxide emissions were estimated based on the percentage of sulfur present in distillate fuel consumed by locomotives. Federal Rule (EPA, 1998b) allows from 0.2 to 0.4 % by weight of sulfur in distillate fuel. The railroad industry uses both high and low sulfur diesel, depending on the cost and availability of low sulfur diesel, however specific information on the quantities of each fuel were not available. A sulfur content of 0.33 % by weight was therefore applied, consistent with the NONROAD model default.

An ammonia emission factor for locomotives was derived from the emission factor published by the EPA OTAQ for diesel fuel consumption. The emission factor was derived from light duty on-road vehicle emission measurements, and extrapolated to non-road engines on a fuel consumption basis.

5.1.3 Aircraft

Aircraft emissions were developed for three separate categories: commercial aviation, military aviation, and general aviation. Each of these categories has distinct characteristics and required a different emissions estimation approach.

Commercial aviation emissions were estimated using detailed aircraft LTO information at Boise Air Terminal supplied in the SAI (1997) emission inventory document for 1995. The model types and 1995 LTO data were entered into the FAA model EDMS 4.0, an aircraft emissions and air quality modeling program (available at http://www.aee.faa.gov/emissions/edms/EDMShome.htm). EDMS also requires input of average total taxi time specific to the airport; this was obtained for the Boise Air Terminal from the FAA EDMS web page. Emissions were then estimated using 1999 emission factors for HC, NOx, CO, and SO_X, and the total emissions were grown using FAA LTO data from 1995 to 1999. HC emissions were converted to VOC using EPA (1992) conversion factors for commercial aircraft. PM10 emissions were derived using the ratio of PM_0 and NOx supplied in EPA NEI99 data.

Military aviation emissions estimates for 1995 were obtained from a report prepared for the Idaho Air National Guard (CH2MHill, 1996). These were grown to 1999 with Bureau of Economic Analysis Idaho gross state product data for the SIC indicator "Federal, Military" (BEA, 2001). VOC and CO emissions were calculated using the ratio of the respective pollutants to NOx in the EPA 1999 NEI data.

EPA emission inventory guidance (EPA, 1992) contains general aviation emissions factors per LTO for HC, CO, NOx, and SO_2; the fleet-average HC to VOC conversion factor is provided in the same document. These emissions were estimated using 1995 general aviation LTO data from the SAI (1997) emission inventory document. These were grown to 1999 with BEA gross state product data for the SIC indicator "Transportation by Air" (BEA, 2001). Evaporative emissions are also very significant for general aviation. These were estimated using the procedures described in a report on aircraft emissions for all Texas airports (TTI, 2000) and national and regional data from the Faa 1999 General Aviation And Air Taxi Activity And Avionics Survey (FAA, 2001). As with commercial aviation, PM_{10} was estimated using EPA 1999 NEI data.

Commercial and military aviation were assumed to be dominated by turbine-powered aircraft running lean, thus producing a negligible amount of ammonia. For general aviation, the fraction of piston aircraft LTO was estimated using FAA (2001) data. The same data source contained information on fuel consumption for these aircraft categories. The NH3 emission factor for non-catalyst light-duty gasoline vehicles used in EPA 1986-1999 emissions trends calculations (EPA, 2001) was assumed for piston aircraft.

5.2 EMISSIONS BY SOURCE CATEGORY

Table 5-2 shows the 1999 average daily emissions by source category, season, and pollutant. The relative emissions contribution of each vehicle class to the combined Ada and Canyon counties emissions for an average winter day in 1999 is shown in Figure 5-1. Off-road categories with sizeable PM_{10} emissions are construction and mining equipment, lawn and garden equipment, industrial equipment, and agricultural equipment. VOC emissions are dominated by lawn and garden equipment. The largest contributors to SO_x and ammonia emission are estimated to be construction and mining equipment, and industrial and commercial equipment.

Table 5-2. 1999 Average winter day, average summer day, and annual off-road emissions by source category.

		Ada County						Canyon County						Ada & Canyon Counties				
Season	**Source Category**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SOx**
Summer (TPD)	Agricultural Equipment	0.531	3.087	3.213	0.261	0.748	0.004	1.022	6.970	5.021	0.538	1.649	0.008	1.553	10.058	8.234	0.799	2.398
	Aircraft	0.876	0.423	16.479	0.033	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.876	0.423	16.479	0.033	0.051
	Airport Ground Support Equipment	0.286	0.224	5.719	0.013	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.286	0.224	5.719	0.013	0.036
	Commercial Equipment	0.743	0.649	16.897	0.072	0.146	0.002	0.200	0.175	4.542	0.019	0.039	0.000	0.942	0.824	21.439	0.092	0.185
	Construction and Mining Equipment	1.312	6.806	8.536	0.765	2.109	0.008	0.317	1.643	2.061	0.185	0.509	0.002	1.628	8.449	10.596	0.949	2.618
	Industrial Equipment	0.267	1.747	6.762	0.150	0.446	0.005	0.127	0.833	3.274	0.069	0.206	0.003	0.395	2.580	10.036	0.220	0.652
	Lawn and Garden Equipment (Com)	6.364	1.689	87.648	0.347	0.398	0.005	0.511	0.136	7.033	0.028	0.032	0.000	6.875	1.825	94.681	0.375	0.430
	Lawn and Garden Equipment (Res)	1.351	0.101	19.171	0.019	0.018	0.001	0.556	0.042	7.894	0.008	0.008	0.000	1.907	0.143	27.065	0.027	0.026
	Locomotives	0.058	1.400	0.140	0.036	0.130	0.001	0.020	0.466	0.047	0.011	0.043	0.000	0.078	1.866	0.186	0.047	0.173
	Logging Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pleasure Craft	0.233	0.019	0.615	0.011	0.007	0.000	0.629	0.050	1.657	0.030	0.018	0.000	0.862	0.069	2.272	0.042	0.024
	Railroad Equipment	0.002	0.009	0.022	0.001	0.004	0.000	0.001	0.004	0.009	0.001	0.002	0.000	0.003	0.013	0.031	0.002	0.005
	Recreational Equipment	0.562	0.082	7.953	0.013	0.018	0.000	0.147	0.023	2.295	0.003	0.005	0.000	0.709	0.105	10.248	0.017	0.023
	Total Non-road	12.584	16.237	173.154	1.722	4.110	0.026	3.530	10.342	33.832	0.893	2.511	0.014	16.114	26.579	206.986	2.615	6.621
Winter (TPD)	Agricultural Equipment	0.082	0.374	0.381	0.032	0.092	0.000	0.150	0.843	0.596	0.065	0.202	0.001	0.233	1.217	0.977	0.097	0.294
	Aircraft	0.876	0.423	16.479	0.033	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.876	0.423	16.479	0.033	0.051
	Airport Ground Support Equipment	0.304	0.256	5.629	0.013	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.304	0.256	5.629	0.013	0.035
	Commercial Equipment	0.776	0.689	16.600	0.074	0.148	0.002	0.208	0.185	4.462	0.020	0.040	0.001	0.984	0.875	21.062	0.094	0.188
	Construction and Mining Equipment	0.307	1.580	1.966	0.176	0.497	0.002	0.074	0.381	0.475	0.042	0.120	0.000	0.381	1.962	2.441	0.218	0.617
	Industrial Equipment	0.190	1.194	4.581	0.102	0.306	0.004	0.090	0.570	2.218	0.047	0.141	0.002	0.280	1.764	6.799	0.149	0.447
	Lawn and Garden Equipment (Com)	3.849	0.488	23.198	0.158	0.077	0.001	0.309	0.039	1.861	0.013	0.006	0.000	4.158	0.527	25.060	0.170	0.083
	Lawn and Garden Equipment (Res)	0.744	0.055	4.543	0.019	0.005	0.000	0.306	0.023	1.871	0.008	0.002	0.000	1.050	0.077	6.414	0.027	0.007
	Locomotives	0.058	1.400	0.140	0.036	0.130	0.001	0.020	0.466	0.047	0.011	0.043	0.000	0.078	1.866	0.186	0.047	0.173
	Logging Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pleasure Craft	0.042	0.002	0.052	0.001	0.001	0.000	0.112	0.005	0.141	0.003	0.001	0.000	0.154	0.006	0.193	0.004	0.002
	Railroad Equipment	0.002	0.009	0.021	0.001	0.004	0.000	0.001	0.004	0.009	0.001	0.002	0.000	0.003	0.013	0.031	0.002	0.005
	Recreational Equipment	0.215	0.024	2.135	0.004	0.004	0.000	0.056	0.007	0.617	0.001	0.001	0.000	0.270	0.031	2.753	0.005	0.005
	Total Non-road	7.443	6.495	75.727	0.648	1.348	0.011	1.327	2.522	12.297	0.210	0.559	0.004	8.771	9.017	88.024	0.857	1.907
Annual (TPY)	Agricultural Equipment	112	633	657	53	154	1	214	1429	1027	110	339	2	327	2062	1685	164	492
	Aircraft	320	154	6015	12	19	0	0	0	0	0	0	0	320	154	6015	12	19
	Airport Ground Support Equipment	108	88	2071	5	13	0	0	0	0	0	0	0	108	88	2071	5	13
	Commercial Equipment	277	244	6113	27	54	1	74	66	1643	7	14	0	352	310	7757	34	68
	Construction and Mining Equipment	296	1533	1920	172	476	2	71	370	464	41	115	0	367	1903	2383	213	591
	Industrial Equipment	83	537	2071	46	137	2	40	256	1003	21	63	1	123	793	3074	67	201
	Lawn and Garden Equipment (Com)	1865	398	20262	92	87	1	150	32	1626	7	7	0	2015	430	21887	100	94
	Lawn and Garden Equipment (Res)	383	28	4335	7	4	0	158	12	1785	3	2	0	540	40	6120	10	6
	Locomotives	21	511	51	13	47	0	7	170	17	4	16	0	28	681	68	17	63
	Logging Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pleasure Craft	50	4	122	2	1	0	135	10	329	6	4	0	186	14	451	8	5
	Railroad Equipment	1	3	8	0	1	0	0	1	3	0	1	0	1	5	11	1	2
	Recreational Equipment	142	19	1844	3	4	0	37	5	532	1	1	0	179	25	2376	4	5
	Total Non-road	3658	4153	45469	433	998	7	888	2352	8429	202	561	3	4545	6505	53899	635	1559

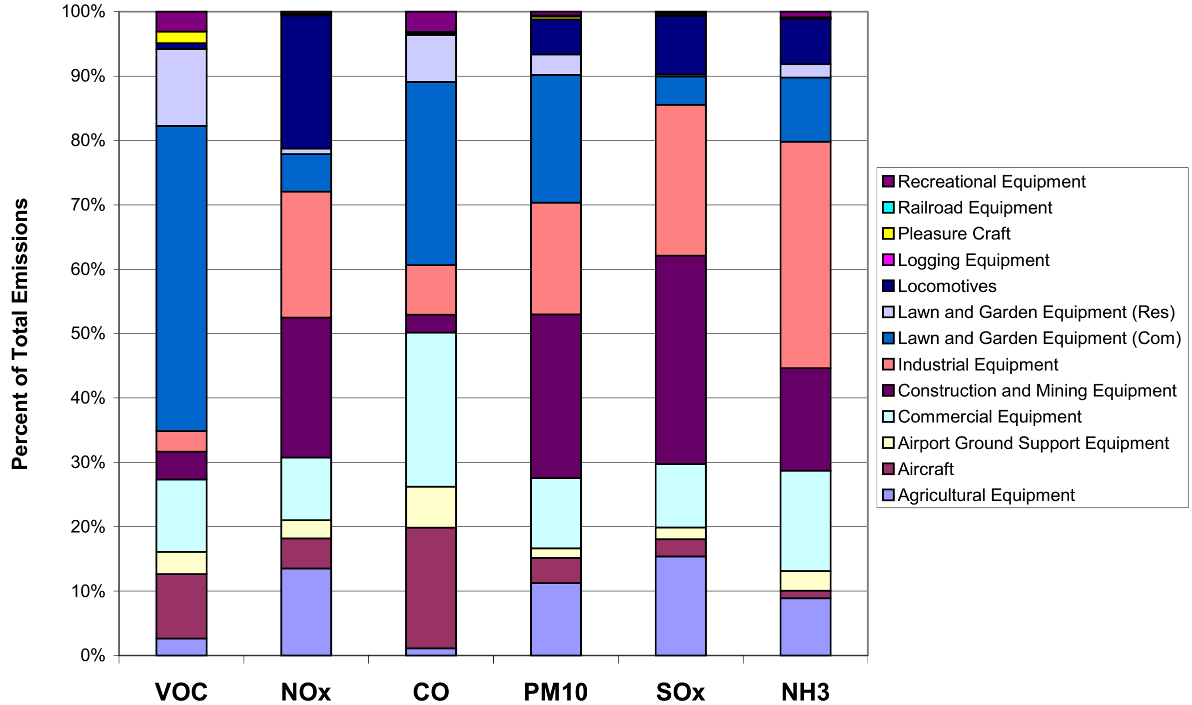

Figure 5-1. Contribution to 1999 average winter day on-road emissions by source category (Ada & Canyon counties).

5.3 DATA MANAGEMENT AND QUALITY ASSURANCE/QUALITY CONTROL

In general, procedures described in *Final Inventory Preparation Plan/Quality Assurance Plan (IPP/QAP)* (ENVIRON, 2001) were used to check, and correct when necessary, the off-road mobile sources emissions estimates. All NONROAD model input and output files, and Excel spreadsheets used to calculate the emissions, were checked by personnel who were not involved in the development of the modeling inputs/outputs and spreadsheets. In addition, the emissions estimates were reviewed for reasonableness by IDEQ staff and external stakeholders.

6.0 1999 EMISSION INVENTORY RESULTS

The previous four sections described the methods used to estimate 1999 annual and episodic emission inventories for point, area, on-road, and off-road sources. These emission inventories were developed for direct emissions of PM_{10}, and for PM_{10} precursors – nitrogen oxides (NO_x), sulfur oxides (SO_x), volatile organic compounds (VOCs), carbon monoxide (CO), and ammonia (NH_3). In this section we provide tables and graphs that show the 1999 annual and episodic emissions for all source categories.

Table 6-1 shows the 1999 base year annual emission inventories for Ada and Canyon counties combined. Figure 6-1 shows the relative contribution of each of the four major source categories to the total emissions for each pollutant. Annual PM_{10} emissions are primarily from fugitive road dust and agricultural activities. NO_x emissions are primarily from on-road and off-road mobile sources. Industrial point sources account for about half of the SO_x emissions, and on-road and non-road mobile sources account for most of the remainder. Livestock is the dominant source of ammonia emissions (about 75%). About 70 percent of the VOC emissions are from area sources, with most of the remainder from mobile sources. CO is almost completely from on-road and off-road mobile sources.

Table 6-1 shows the emissions for the highest concentration day in the 1999 episode – December 24; the relative contributions by major source category are shown in Figure 6-2. For industrial point sources the emissions are actual emissions as reported by the point sources in the Point Source Questionnaire. For area, on-road mobile, and off-road mobile sources, seasonal and weekday/weekend adjustment factors were used to generate the daily emission inventories for each day of the 1999 episode. December 24, 1999, though a Friday, was treated as a weekend day because it is a holiday and activity was thought to be more typical of weekends than weekdays. Open burning was zeroed out in the episodic emission inventories as such activity was virtually nonexistent during the winter.

On the December 24, 1999 episode day, almost 90 percent of the PM_{10} emissions are from fugitive road dust, and about 7 percent of the emissions are from residential wood combustion. NO_X emissions are dominated by mobile sources (54 percent from on-road and 16 percent from off-road), with point sources accounting for 18 percent and area sources (mostly fuel combustion) accounting for the remaining 12 percent. Industrial point sources account for 80 percent of the SO_X emissions, with the remainder from mobile sources. As for the annual emissions, livestock is the dominant source of ammonia emissions. The largest source category for VOC emissions is residential wood combustion (42 percent), with other area sources (mostly solvent usage) accounting for 18 percent, and mobile sources accounting for 31 percent. CO emissions are dominated by mobile sources (64 percent on-road and 18 percent off-road mobile), with the remainder from residential and other fuel combustion.

Table 6-1. 1999 annual emission inventories, Ada and Canyon counties combined.

	PM_{10}		NOx		SOx		NH3		VOC		CO	
Source Category	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**
Industrial Point Sources	**1,173**	**2.3%**	**1,796**	**9.0%**	**1,715**	**45.2%**	**405**	**5.9%**	**1,164**	**3.4%**	**1,984**	**1.4%**
Area Sources	**21,775**	**43.6%**	**1,734**	**8.7%**	**103**	**2.7%**	**6,260**	**91.3%**	**23,313**	**68.4%**	**11,798**	**8.3%**
Residential Wood Combustion	526	1.1%	48	0.2%	7	0.2%	0	0.0%	2,209	6.5%	3,831	2.7%
Other Fuel Combustion	147	0.3%	871	4.4%	61	1.6%	7	0.1%	41	0.1%	482	0.3%
Open Burning	2,094	4.2%	254	1.3%	35	0.9%	0	0.0%	1,754	5.1%	7,485	5.2%
Agricultural Activities	15,746	31.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Other Fugitive Dust	3,262	6.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Ammonia sources	0	0.0%	0	0.0%	0	0.0%	6,253	91.2%	0	0.0%	0	0.0%
Biogenic Emissions	0	0.0%	561	2.8%	0	0.0%	0	0.0%	11,090	32.5%	0	0.0%
VOC Sources	0	0.0%	0	0.0%	0	0.0%	0	0.0%	8,219	24.1%	0	0.0%
On-Road Mobile Sources	**26,357**	**52.8%**	**9,932**	**49.7%**	**418**	**11.0%**	**184**	**2.7%**	**5,052**	**14.8%**	**75,303**	**52.7%**
Vehicle Emissions (Exhaust, Tire Wear, & Brake Wear)	382	0.8%	9,932	49.7%	418	11.0%	184	2.7%	5,052	14.8%	75,303	52.7%
Fugitive Road Dust	25,975	52.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Non-Road Mobile Sources	**635**	**1.3%**	**6,505**	**32.6%**	**1,559**	**41.1%**	**10**	**0.1%**	**4,545**	**13.3%**	**53,899**	**37.7%**
Aircraft	12	0.0%	154	0.8%	19	0.5%	0	0.0%	320	0.9%	6,015	4.2%
Airport Ground Support Equipment	5	0.0%	88	0.4%	13	0.3%	0	0.0%	108	0.3%	2,071	1.4%
Lawn & Garden Equipment	110	0.2%	470	2.4%	100	2.6%	1	0.0%	2,555	7.5%	28,008	19.6%
Recreational Equipment	4	0.0%	25	0.1%	5	0.1%	0	0.0%	179	0.5%	2,376	1.7%
Commercial and Industrial Equipment	101	0.2%	1,103	5.5%	269	7.1%	3	0.0%	475	1.4%	10,831	7.6%
Construction and Mining Equipment	213	0.4%	1,903	9.5%	591	15.6%	2	0.0%	367	1.1%	2,383	1.7%
Agricultural Equipment	164	0.3%	2,062	10.3%	492	13.0%	2	0.0%	327	1.0%	1,685	1.2%
Recreational Marine Vessels	8	0.0%	14	0.1%	5	0.1%	0	0.0%	186	0.5%	451	0.3%
Locomotives and Railroad Equipment	18	0.0%	686	3.4%	65	1.7%	0	0.0%	30	0.1%	79	0.1%
TOTAL	**49,939**		**19,967**		**3,795**		**6,859**		**34,074**		**142,984**	

Table 6-2. 1999 episode emission inventories, Ada and Canyon Counties combined. Emissions are for December 24, 1999, the highest concentration day during the episode.

	PM10		NOx		SOx		NH3 (tons/year)		VOC		CO	
Source Category	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**
Industrial Point Sources	**2.19**	**3.0%**	**7.38**	**18.3%**	**10.01**	**80.3%**	**1.77**	**10.6%**	**1.94**	**3.7%**	**16.70**	**5.3%**
Area Sources	**5.60**	**7.6%**	**4.83**	**12.0%**	**0.38**	**3.0%**	**14.48**	**87.1%**	**33.97**	**65.1%**	**39.25**	**12.4%**
Residential Wood Combustion	5.06	6.9%	0.46	1.1%	0.07	0.6%	0.00	0.0%	21.71	41.6%	36.88	11.6%
Other Fuel Combustion	0.52	0.7%	3.69	9.1%	0.31	2.5%	0.03	0.2%	0.19	0.4%	2.32	0.7%
Open Burning	0.02	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.01	0.0%	0.05	0.0%
Agricultural Activities	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Other Fugitive Dust	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Ammonia sources	0.00	0.0%	0.00	0.0%	0.00	0.0%	14.45	86.9%	0.00	0.0%	0.00	0.0%
Biogenic Emissions	0.00	0.0%	0.67	1.7%	0.00	0.0%	0.00	0.0%	2.87	5.5%	0.00	0.0%
VOC Sources	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	9.19	17.6%	0.00	0.0%
On-Road Mobile Sources	**65.43**	**88.7%**	**21.90**	**54.3%**	**0.84**	**6.7%**	**0.37**	**2.2%**	**11.87**	**22.8%**	**203.57**	**64.2%**
Vehicle Emissions (Exhaust, Tire Wear, & Brake Wear)	0.41	0.6%	21.90	54.3%	0.84	6.7%	0.37	2.2%	11.87	22.8%	203.57	64.2%
Fugitive Road Dust	65.02	88.2%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Non-Road Mobile Sources	**0.51**	**0.7%**	**6.26**	**15.5%**	**1.24**	**9.9%**	**0.01**	**0.1%**	**4.39**	**8.4%**	**57.80**	**18.2%**
Aircraft	0.03	0.0%	0.42	1.0%	0.05	0.4%	0.00	0.0%	0.88	1.7%	16.48	5.2%
Airport Ground Support Equipment	0.01	0.0%	0.27	0.7%	0.01	0.1%	0.00	0.0%	0.30	0.6%	5.54	1.7%
Lawn & Garden Equipment	0.06	0.1%	0.21	0.5%	0.04	0.3%	0.00	0.0%	1.54	3.0%	13.54	4.3%
Recreational Equipment	0.01	0.0%	0.05	0.1%	0.01	0.1%	0.00	0.0%	0.32	0.6%	4.09	1.3%
Commercial and Industrial Equipment	0.16	0.2%	1.62	4.0%	0.44	3.5%	0.00	0.0%	0.74	1.4%	15.59	4.9%
Construction and Mining Equipment	0.12	0.2%	1.11	2.7%	0.35	2.8%	0.00	0.0%	0.21	0.4%	1.37	0.4%
Agricultural Equipment	0.05	0.1%	0.69	1.7%	0.17	1.3%	0.00	0.0%	0.12	0.2%	0.54	0.2%
Recreational Marine Vessels	0.01	0.0%	0.02	0.0%	0.00	0.0%	0.00	0.0%	0.19	0.4%	0.46	0.1%
Locomotives and Railroad Equipment	0.05	0.1%	1.87	4.6%	0.17	1.4%	0.00	0.0%	0.08	0.2%	0.20	0.1%
TOTAL	**73.74**		**40.36**		**12.46**		**16.62**		**52.16**		**317.32**	

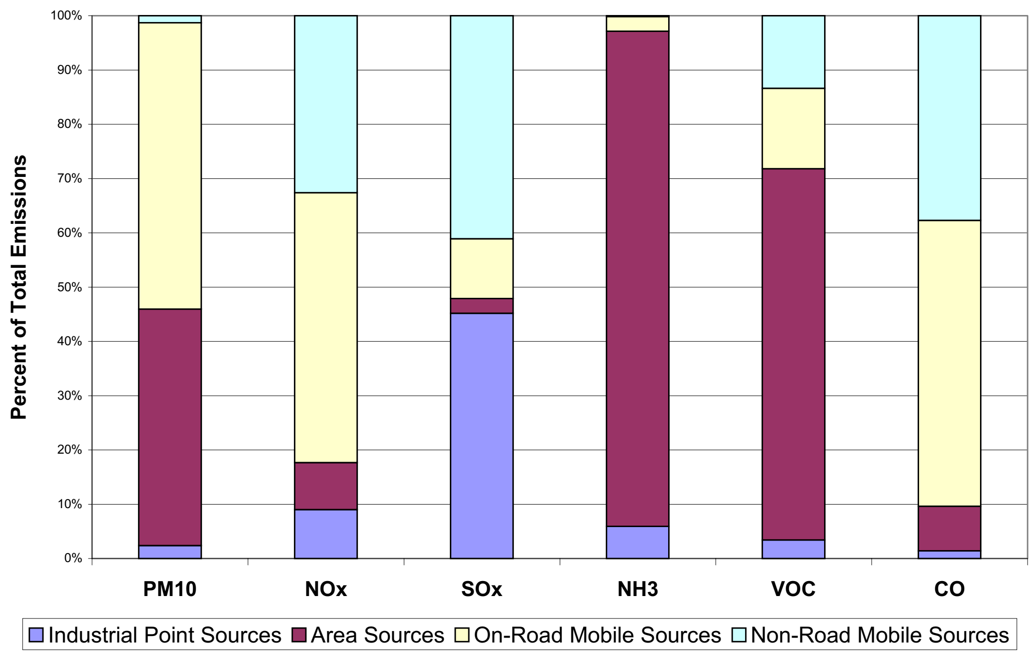

Figure 6-1. Contribution to 1999 annual emissions by major source category (Ada and Canyon counties).

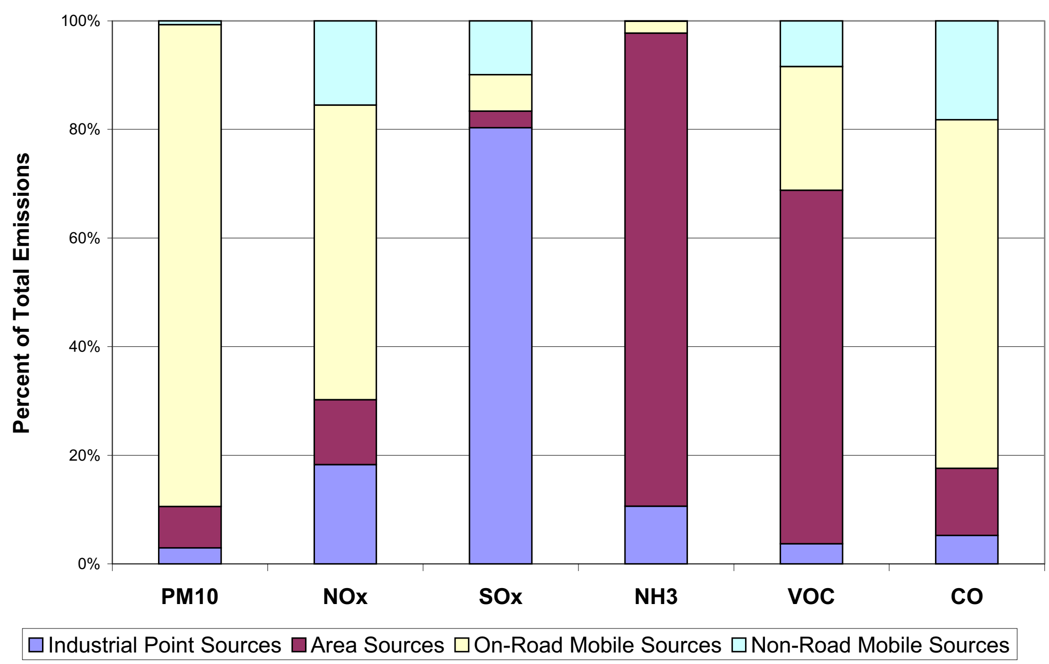

Figure 6-2. Contribution to December 24, 1999 emissions by major source category (Ada and Canyon counties).

7.0 FUTURE YEAR POINT SOURCES

For purposes of air quality modeling in a SIP attainment demonstration for future years, it is necessary to estimate maximum potential emissions from point sources. This level of potential to emit (PTE) is defined as "the potential rate of emissions of a pollutant from an emissions unit calculated using the unit's maximum design capacity. Potential emissions are a function of the unit's physical size and operation capabilities" (STAPPA/ALAPCO, 2001). In general, PTE for the point sources within the Ada and Canyon county domain was determined by one of the following conditions for each stack, process, or fugitive source expected to operate in the future at an industrial facility:

- A permit limit established by the DEQ; or
- The maximum potential rate of emissions possible from the stack, process, or fugitive as determined by the emission source's operating design capacity or by assuming continuous operation (e.g., 365 days per year, etc.).

The industrial point source inventory for future years includes the six pollutants (i.e., PM_{10}, NO_x, SO_x, NH_3, CO, and VOC) for the years of 2010, 2015, and 2020. Both annual and daily PTE was estimated. Details regarding the future year point sources data collection, emission estimation methodology, and QA/QC procedures are discussed in the remainder of this section.

7.1 DATA COLLECTION PROCEDURES AND RESULTS

The basis for data collection of point source emissions information was the PSQ. The PSQ packet contained 14 forms and other information to assist in completing the forms (see Section 2, above, for a detailed description of the PSQ). Form SUM was used by each facility to record its 1999 annual emissions and maximum potential annual emissions either based on a permit limit or a maximum PTE as defined above.

Of the 160 facilities who were mailed PSQ packets by DEQ, 122 recorded permitted emissions and/or maximum PTE on Form SUM. One other facility, Garnet Energy, did not complete a PSQ since their operation is still speculative; however, emissions estimates developed as part of the air quality impacts analysis by DEQ, were used to determine PTE for this prospective facility.

For some facilities, not all sources (e.g., combustion, process, or fugitive) that operated in 1999 were expected to operate in the future due to reasons such as equipment phase-out. Other facilities actually reported more emission sources in the future years than in the 1999 base year due to new equipment installation.

For facilities reporting permitted limits on the Form SUM, the information was determined in either one of two ways:

- Based on a DEQ permit for facility-wide operation (i.e., "bubble" permit); or

- A Tier II limit provided by DEQ on a source-by-source basis.

Bubble permit limits for two Monroc Concrete and Nelson Construction facilities in Ada Canyon have been replaced with source-based permit limits.

7.2 EMISSION CALCULATION METHODOLOGY

A draft procedure for determining future year (annual and daily) emissions was developed and submitted to U.S. EPA, Region 10, for approval. Based on Region 10's comment, the procedure was revised. The final procedure is summarized in Table 7-1. As shown in Table 7-1 and described above, the data collected in the PSQ process provided part of the information needed to determine PTE for each facility. Details of the methods and data used to estimate future year annual and daily emissions are described below.

7.2.1 All Sources – Annual and Daily PTE (Permitted)

The methodology used to estimate annual and daily PTE from permitted combustion, materials handling, and general sources (i.e., excluding fugitive dust and VOC sources which have no annual permit limits in terms of pounds/year) was based on the permit limit recorded by the facility on the Form SUM. A facility with an annual permit limit for a given source might have a daily permit limit for the same source. In the absence of a daily permit limit, the daily permit value was estimated based on the annual permit limit using the following equation:

$$ED_{future} = P / D$$

where:

ED_{future} = daily emissions in the future year (pounds/day);
P = Permitted limit (pounds/year); and
D = normal number of days of operation (days/year).

A sample calculation using this equation for estimating daily PTE for permitted sources is as follows:

where:

P = 100,000 pounds/year (from PSQ based on permit limit);
D = 312 days/year (from PSQ); and
ED_{future} = 321 pounds/year.

7.2.2 Fugitive Dust Sources – Annual PTE (Non-Permitted)

The calculation methodology used to estimate annual PTE was the same for all non-permitted fugitive dust sources (i.e., transfers and conveyors, storage pile wind erosion, and unpaved and paved industrial roads). The emission estimation equation, which assumes 365 days of operation of each future year, is as follows:

$$E_{future} = (E_{1999} / D_{1999}) \times 365$$

where:

E_{future} = annual emissions of PM_{10} in the future year (pounds/year);
E_{1999} = annual emissions of PM_{10} in 1999 (pounds/year); and
D_{1999} = actual days of operation in 1999.

A sample calculation using this equation for estimating PM_{10} emissions from a fugitive dust source is as follows:

where:

E_{1999} = 2,500 pounds (from PSQ); and
D_{1999} = 260 days (from PSQ based on 5 days during each week).

$$E_{future} = (2{,}500/260) \times 365 = 3{,}510 \text{ pounds/year}$$

7.2.3 Combustion and Process Sources – Annual PTE (Non-Permitted)

Annual PTE was estimated for non-permitted combustion and process sources (e.g., materials handling, milling, etc.) according the procedures described below.

7.2.3.1 Combustion Sources

The emission estimation equation used to estimate annual PTE for non-permitted combustion sources is as follows:

$$E_{future} = EF \times A_{max} \times (1 - C/100)$$

where:

E_{future} = annual emissions in the future (pounds/year);
EF = emission factor (pounds/activity unit);
A_{max} = maximum annual activity level (activity units/year); and
C = overall control efficiency.

A sample calculation using this equation for estimating NO_x emissions from a drum mix asphalt plant, natural gas-fired dryer (i.e., SCC 3-05-002-55) is as follows:

where:

EF = 0.026 pounds of NO_x per ton of HMA (from AP-42, Table 11.1.7);
A_{max} = 500,000 tons of HMA produced at maximum per year (from PSQ);
C = 95% (based on engineering estimate provided by facility); and
E_{future} = 0.026 x 500,000 x (1 – 95/100) = 650 pounds of NO_x per year.

7.2.3.2 Materials Handling and General Sources

The equation used to estimate annual PTE for non-permitted materials handling and general sources, which assumes 8,760 hours/year of operation, is as follows:

$$E_{future} = EF \times A_{max} \times 8{,}760 \times (1 - C/100)$$

where:

E_{future} = annual emissions in the future (pounds/year);
EF = emission factor (pounds/activity unit);
A_{max} = maximum hourly activity level (activity units/hour); and
C = overall control efficiency.

A sample calculation using this equation for estimating PM_{10} emissions from wood waste storage bin load out (i.e., SCC 03-07-030-02) is as follows:

where:

EF = 1.2 pounds of PM_{10} per ton of wood waste loaded (U.S. EPA, 2000);
A_{max} = 100 tons of wood waste per hour (from PSQ);
C = 99% (based on engineering estimate provided by facility); and
E_{future} = 1.2 x 100 x 8,760 x (1 – 99/100) = 10,512 pounds of PM_{10} per year.

7.2.3.3 VOC Sources

The equation used to estimate annual PTE for non-permitted VOC sources (e.g., solvent usage, degreasing, etc.) is as follows:

$$E_{future} = E_{1999} \times (A_{max} / A_{1999})$$

where:

E_{future} = annual emissions of VOC in the future year (pounds/year);
E_{1999} = annual emissions of VOC in 1999 (pounds/year);
A_{max} = maximum annual activity level (activity units/year); and
A_{1999} = annual activity level in 1999 (activity units/year).

The 1999 and maximum activity levels used in this equation are for a major process within the facility, and have the same units. In this equation, the activity level of the major process is a surrogate for the maximum amount of VOC-containing solvent usage expected at the facility. Other surrogates (e.g., transfer rates, production rates, etc.) may be used.

A sample calculation using this equation for estimating VOC emissions from solvent usage is as follows:

where:

E_{1999} = 8,250 pounds of VOC (from PSQ);
A_{max} = 100,000 Btu of fuel (from PSQ); and
A_{1999} = 1,000 Btu of fuel (from PSQ).

$$E_{future} = 8{,}250 \times (100{,}000 / 1{,}000) = 82{,}500 \text{ pounds of VOC per year}$$

7.2.4 All Sources – Daily PTE (Non-Permitted)

Daily PTE was calculated in the same manner for all non-permitted sources with one exception, which is explained below. The general calculation used to estimate daily PTE for non-permitted sources, which assumes 365 days per year of operation, is as follows:

$$ED_{future} = E_{future} / 365$$

where:

ED_{future} = average daily emissions in the future (pounds/day); and
E_{future} = annual PTE (pounds/year).

The only exception to this general calculation for daily PTE from non-permitted sources is for combustion emissions. For combustion emissions, the 365 is replaced with the number of normal days of operation per year. This gives a more conservative estimate of average daily emissions than if the 365 days/year assumption is used. The more conservative estimate is felt to be appropriate for use in this SIP modeling analysis.

A sample calculation using this equation for estimating daily PTE of NO_x from the drum mix asphalt plant, natural gas-fired dryer used in the example in Section 7.2.3.1, above, is as follows:

where:

E_{future} = 650 pounds of NO_x per year; and
D = 210 days (from PSQ).
ED_{future} = 650 / 210 = 3 pounds of NO_x per day

7.2.5 Episode Adjustments

As mentioned above, daily episode emissions were estimated based on January 1991 meteorological conditions. The three conditions, including their particular characteristics effecting point source emissions (i.e., fugitive dust sources), are as follows:

- Condition #1, Single-digit weekday:
  - Zero precipitation;
  - Wind speed < 12 mph; and
  - 7” snow cover.

- Condition #2, Double-digit weekday:
  - Trace precipitation;
  - Wind speed < 12 mph; and
  - 7” snow cover.

- Condition #3, Weekend day:
  - Zero precipitation;
  - Wind speed < 12 mph; and
  - 7” snow cover.

The effects of these conditions on specific industrial fugitive dust sources, which were included in the methodology shown in Table 7-1 and approved by U.S. EPA, Region 10, are as follows:

- Storage pile wind erosion—emissions are zero under all 3 conditions due to low wind speeds; and
- Transfers/conveyors and paved/unpaved industrial roads—emissions are zero under Condition #2 due to trace precipitation.

7.3 EMISSIONS BY FACILITY

Table 7-2 shows the results of the projected annual emissions inventory for point sources expected to operate in Ada and Canyon Counties during the future years of 2010, 2015, and 2020. Facilities are listed based on their expected PM_{10} emissions, with the largest emitter first. Two important issues should be noted regarding this, and other tables summarizing the future year emissions inventory:

- First, annual emissions are assumed to be equal for each of the future years because it is anticipated that these same facilities will operate during the decade from 2010 to 2020, and at the same basic level of operation.
- Second, due to concurrent permitting and emissions trading activities conducted by DEQ during the time the inventory was prepared and air quality modeling was performed, it was necessary to change some of the PM_{10} inventory estimates as shown on Table 7-2, and Tables 7-3a and 7-3b (discussed below). Thus, the PM_{10} facility inventory totals shown on these tables do not correspond to estimates listed in the SIP. Specific facilities affected by these activities are: Nelson Construction Co. (permit was revised), Monroc Concrete (permit was revised), C. Wright Construction (permit revision is in progress), and Croman Corporation (out of business, but emissions were increased to account for emissions trading).

Based on the inventory estimates summarized in Table 7-2 (not including the adjustments made for air quality modeling noted above), the total future year PM_{10} emissions are expected to be 5,278.9 tons. The largest emitter of PM_{10}, SO_x, CO, and NH_3 on an annual basis is expected to be the TASCO facility in Nampa (Canyon County).

Tables 7-3a and 7-3b show the daily emissions by facility for each pollutant during the future year episodes by day type (i.e., single-digit weekday, double-digit weekday, and weekend day. Facilities are listed based on their expected total PM_{10} emissions, with the largest emitter first. Only PM_{10} emissions vary among the day types due to the (controlling) effect of precipitation on fugitive dust sources on the double-digit weekday (see Section 7.2.5 for details on episode adjustments). For each day type, the largest emitters of PM_{10} are TASCO, Garnet Energy, J.R. Simplot Company (Caldwell), Nelson Construction—Amity, Micronpc.com, and Nampa Paving. These facilities combine for a total of approximately 13,350 tons for single-digit weekdays shown on Table 7-3a (i.e., 34% of the total daily PM_{10} emissions). (Again, note that the Nelson Construction PM_{10} emissions were revised for air quality modeling due to new, lower, permit limits). Micronpc.com is expected to emit nearly half (i.e., 46%) of the total

NO_x emissions under each of the three conditions. TASCO is expected to emit more than half of the daily SO_x, CO, and NH_3 emissions under each of the three conditions.

7.4 DATA MANAGEMENT AND QUALITY ASSURANCE/QUALITY CONTROL

In addition to the completeness, accuracy, and data entry reviews described above in Section 2, several specific QA/QC reviews were conducted that pertained to future year emission estimates, including:

- Accuracy review of the PTE estimates provided by the facilities on their PSQ (Form SUM). Every PTE estimate was checked and changes were made as appropriate. Also, when backup calculations were performed, copies of the calculations were physically attached to the PSQ for that facility. Most facilities either left this information off of the form, or made an incorrect calculation due to reasons such as the complexity of the calculation or current work to develop new permit limits. Thus, much effort was spent in this step to estimate the emissions correctly.
- Accuracy review of inventory results. For example, missing facilities were identified by comparing the facilities listed in the PTE spreadsheets to those contained in the base year spreadsheets. In some cases (e.g., Garnet Energy) new facilities are coming on line in the future, so they were not included in the 1999 inventory. All errors were corrected when encountered.
- A final check for completeness and accuracy was a peer review by the facilities of the draft point sources emissions inventory. DEQ distributed a table of results for review by the facilities, and then upon request, detailed spreadsheets with source-by-source results were provided to the facilities.

Table 7-1. Summary of procedure for estimating future year emissions for point sources.

Source Type	Annual Allowable (Permitted Sources)	Annual PTE (Non-Permitted Sources)[a]	Daily (Permitted Sources)	Daily (Non-Permitted Sources)
Fugitive dust, transfers/ conveyors	N/A[b]	1999 lbs/year x (365/actual number of days operated in 1999)	N/A[b]	Annual PTE/365[c,d]
Fugitive dust, storage pile wind erosion	N/A[b]	1999 lbs/year x (365/actual number of days operated in 1999)	N/A[b]	Annual PTE/365[c,d]
Fugitive dust, unpaved roads	N/A[b]	1999 lbs/year x (365/actual number of days operated in 1999)	N/A[b]	Annual PTE/365[c,d]
Fugitive dust, paved roads	N/A[b]	1999 lbs/year x (365/actual number of days operated in 1999)	N/A[b]	Annual PTE/365[c,d]
Combustion[e]	Annual permit limit	EF x Maximum annual fuel usage	Daily permit limit or annual permit limit/normal number of days per year operation	Annual PTE/normal number of days per year operation
Materials handling[e]	Annual permit limit	EF x Maximum hourly transfer rate x 8,760 hours	Daily permit limit or annual permit limit/normal number of days per year operation	Annual PTE/365[d]
General process sources[e]	Annual permit limit	EF x Maximum hourly production rate x 8,760 hours	Daily permit limit or annual permit limit/normal number of days per year operation	Annual PTE/365[d]
VOC sources[e]	N/A[b]	1999 lbs/year x (Maximum annual fuel usage/1999 fuel usage)[f]	N/A[b]	Annual PTE/365[d]

EF = emission factor
lbs = pounds
mph = miles per hour
N/A = not applicable
PTE = potential to emit
VOC = volatile organic compound

a. Estimates using emission factors should be adjusted to include the effect of controls, as applicable, by multiplying by 1 – (control efficiency %/100). Where 1999 annual emissions are used to calculate PTE, then it is assumed that the effect of controls are already accounted for in the 1999 estimate.

b. No industrial fugitive dust or fugitive VOC sources are affected by permit limits.

c. Calculation is based on daily operation for 365 days/year (fugitive dust) or hourly operation for 8760 hours/year (materials handling, general, and VOC sources).

d. The following (1991) meteorological conditions will be used to determine daily PTE emissions:

   1. Single-digit weekday:Precipitation =0; wind speed <12 mph; 7" snow on ground
   2. Double-digit weekday:Precipitation =trace; wind speed <12 mph; 7" snow on ground
   3. Weekend: Precipitation =0; wind speed <12 mph; 7" snow on ground

   The effect of these meteorological conditions on the daily PTE estimates will be accounted for as follows:

   - Fugitive Dust, Storage Pile Wind Erosion – Emissions will be zero under all 3 conditions since wind speed is <12mph.
   - Fugitive Dust, Transfers/Conveyors, Unpaved and Paved Roads – Emissions will be zero under Condition 2 due to precipitation.
   - It is assumed that there is no measurable effect on the fugitive dust emissions at the industrial facilities due to 7" of snow on ground.

e. Daily estimates for combustion, materials handling, general, and VOC sources assume year-round operation, and do not differentiate between weekday and weekend operations, or changes in meteorology (per footnote d). Also, since these emissions are not affected by meteorology, the emissions will be the same for each of the three meteorological conditions listed in footnote (d).

f. As appropriate for some facilities another ratio was used such as:

   - (Max. Hourly Transfer Rate)/(Normal Hourly Transfer Rate); or
   - (Max. Hourly Production Rate)/(Normal Hourly Production Rate); or
   - (Max. Operation Schedule [8760 hours/year])/(Normal Operating Schedule).

Table 7-2. Future Year Point Sources Annual Emissions by Facility (tons): 2010, 2015, and 2020.

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	1,220.5	3,350.8	5,308.0	110.7	7,907.5	675.3
J.R. Simplot Company - Caldwell	Canyon	280.8	128.5	91.0	51.4	137.8	-
Micronpc.com	Canyon	201.6	7,423.9	16.4	146.3	2,225.7	84.6
Garnet Energy	Canyon	175.1	146.9	72.8	94.6	196.7	188.4
Rock Contractors, Inc.	Canyon	139.7	37.4	2.5	3.0	8.1	-
Nampa Paving & Asphalt Co.	Canyon	137.7	32.3	5.7	39.5	160.3	-
ConAgra Beef Company	Canyon	117.9	37.2	0.2	2.0	31.3	5.7
Nelson Construction Co.	Canyon	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-Pleasant Valley	Ada	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-Middleton	Canyon	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-Flying Wye(777-00226)	Ada	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-Flying Wye	Ada	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-Eagle Island	Ada	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-Diamond	Ada	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-Amity(777-00208)	Ada	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-Amity	Ada	99.0	99.0	99.0	99.0	99.0	-
Nelson Const. Co.-AD111	Ada	99.0	99.0	99.0	99.0	99.0	-
Monroc-Nampa	Canyon	99.0	99.0	99.0	99.0	99.0	-
Monroc-Boise Facility	Ada	99.0	99.0	99.0	99.0	99.0	-
Monroc Concrete	Ada	99.0	99.0	99.0	99.0	99.0	-
Castle Wood Products	Ada	93.6	16.1	1.1	1.3	3.5	-
Can-Ada Crushing	Ada	86.9	160.5	15.1	10.6	36.7	-
Turner Sand and Gravel-Boise	Ada	86.7	-	-	-	-	-
Builders Masonry Products	Ada	68.7	1.1	0.0	0.2	1.0	0.0
Simplot-Wst.Stock.	Canyon	67.6	4.6	0.0	0.3	3.9	-
Woodgrain Millwork	Canyon	61.1	1.9	0.0	1.3	0.6	0.0
Central Paving PRC	Ada	57.5	59.3	3.9	-	12.8	-
Summit Stone	Ada	53.9	115.3	7.6	-	24.8	-
Evans Grain, Feeds & Seed Co.	Canyon	52.9	-	-	-	-	-
Hidden Hollow Landfill	Canyon	50.4	11.8	0.8	20.0	7.6	-
J. R. Simplot Company, Nampa Potato Plant	Canyon	47.8	88.0	0.5	59.7	69.3	2.3
Micron Technology	Ada	44.0	229.2	18.7	118.6	125.8	10.2
Boise Cascade Container	Canyon	39.1	3.8	0.1	20.2	10.1	0.4
Rambo Crushing Co.	Canyon	38.8	-	-	-	-	-
Clements Concrete	Ada	38.3	-	-	-	-	-
Central Paving, Inc. #2	Ada	35.3	2.0	8.0	1.7	2.2	-
SSI Food Svc	Canyon	34.6	16.0	0.1	0.9	13.5	0.5
Ruschman Sand and Gravel, Inc.	Ada	32.6	83.7	5.7	6.8	18.1	-
C. Wright Construction	Ada	32.4	0.6	0.1	1.2	3.0	-
Prime Earth	Ada	29.3	29.1	1.9	2.4	6.4	-
Central Paving, Inc. #1	Ada	26.9	55.0	4.0	26.2	96.0	-
Low's Ready Mix, Inc. - Star West Facility	Canyon	26.0	13.4	0.9	1.1	18.5	-
Sorrento Lactalis	Canyon	25.6	11.9	0.1	1.3	19.6	0.1

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
Nelson-Deppe Inc. - Ada	Ada	24.4	99.8	6.6	-	21.5	-
IBP	Ada	23.9	64.1	92.8	7.6	30.6	1.8
Chevron Pipeline Boise	Ada	23.8	1.8	0.0	240.2	0.7	-
Snake River Chemicals, Inc.	Canyon	23.3	0.0	0.0	0.0	0.0	-
Syngenta Seeds, Inc.-Nampa Plant	Canyon	23.1	3.0	0.0	0.1	0.4	-
Nelson-Deppe Inc. - Canyon	Canyon	22.9	93.6	6.2	-	20.1	-
Darling International Inc.	Ada	22.6	18.4	0.8	4.6	16.9	1.2
Unaga-Eusti Enterprises, Inc. (G&B Redi)-Star Pit	Canyon	20.2	12.7	0.2	0.4	3.4	-
Quality Sand & Gravel	Ada	20.1	14.4	0.9	1.6	3.1	-
Consolidated Concrete Company Aspen Road Facility	Ada	20.1	-	-	-	-	-
Idaho Sand & Gravel	Canyon	19.2	36.3	38.3	21.1	99.0	-
Mike's Sand and Gravel	Ada	18.5	-	-	-	-	-
Centerlane Paving, LLC	Ada	18.4	326.8	157.4	55.2	202.2	-
Pacific Press Publishing Association	Canyon	18.1	6.5	0.1	16.7	1.8	0.0
Capital Paving Company	Ada	17.3	0.0	0.0	2.7	1.0	-
Westfarm Foods-Caldwell	Canyon	17.3	27.6	0.2	2.1	19.3	7.4
Sawtooth Forest Products	Canyon	17.1	-	-	-	-	-
Croman Corporation	Ada	16.7	20.2	0.1	0.8	12.1	0.5
Idaho Asphalt	Canyon	16.4	20.5	0.1	28.3	11.7	0.7
Western World, Inc. Circle J Trailers	Canyon	16.4	-	-	150.0	-	-
Bowman Sand and Gravel	Canyon	16.1	55.7	3.7	6.4	12.0	-
Canyon Sand and Gravel, Inc.	Canyon	14.5	69.5	11.3	2.0	19.0	-
Trus Joist Product Development Center	Ada	13.5	-	-	-	-	-
Plum Creek Northwest Lumber, Inc.	Ada	13.0	-	-	-	-	-
Fleetwood Homes	Canyon	11.8	-	-	46.9	-	-
Low's Ready Mix, Eagle	Ada	9.5	-	-	-	-	-
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	8.7	0.1	0.3	3.1	0.0	0.0
Jabil Circuit	Ada	8.6	0.3	0.0	21.1	0.2	-
White's Hauling & Farm	Canyon	8.1	-	-	-	-	-
American Paving Company	Ada	7.7	7.7	1.5	4.5	18.3	-
Simplot AgriSource - Nampa	Canyon	6.2	-	-	-	-	-
Crookham	Canyon	6.2	3.5	0.0	0.2	3.0	0.1
Idaho Air National Guard	Ada	6.2	69.3	1.1	25.9	49.2	0.0
Northwest Pipeline	Ada	5.8	314.0	12.3	9.2	117.7	-
Seminis Veg. Seeds	Canyon	5.4	20.6	0.1	1.1	17.3	0.7
Motivepower, Inc. Apple Street	Ada	4.7	4.4	0.0	63.0	3.7	-
Western Construction-Crusher #00042	Canyon	4.6	1.3	0.1	0.0	0.3	-
Idaho Concrete Company	Canyon	4.2	-	-	-	-	-
LP Wood Polymers, Inc.	Ada	3.5	3.1	-	2.9	1.2	-
Motivepower, Inc., Branniff Street	Ada	3.0	73.1	4.8	12.4	17.0	0.0
Zamzow's Feed Mill	Ada	2.9	0.1	0.0	0.0	0.1	0.0
Monroc-Middleton	Canyon	2.7	-	-	-	-	-
Hewlett Packard Company	Ada	2.6	37.6	2.5	45.6	8.5	0.0
Koch Materials Company	Ada	2.6	20.4	63.8	78.0	5.0	0.5
Boise Airport	Ada	2.5	0.1	0.0	1.6	0.0	0.0
Western Electronics LLC	Ada	1.5	2.3	-	1.1	0.5	-

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
West Boise WWTF	Ada	1.3	57.3	6.2	3.9	11.7	1.9
Teton Sales Company	Canyon	1.2	0.4	0.0	310.2	0.2	-
Zilog, Inc.	Canyon	1.0	23.3	2.0	35.5	12.5	20.1
Atlas Pallet Co.	Canyon	1.0	-	-	-	-	-
Lander St. WWTF	Ada	1.0	33.6	10.1	2.4	11.2	0.3
Idaho Truss & Component Company	Ada	0.9	-	-	-	-	-
Riverside Crematory	Ada	0.9	5.9	0.8	0.1	0.2	-
Zilog Inc.	Canyon	0.8	19.8	1.8	35.4	10.2	3.8
Westfarm Foods-Boise	Ada	0.7	4.6	0.5	0.6	7.7	0.3
MCMS, Inc.	Canyon	0.7	4.7	0.0	419.7	3.1	0.1
Harris Moran Seed Co.	Canyon	0.6	1.9	0.0	0.2	3.2	-
Clayton's Calcium, Inc.	Ada	0.5	-	-	-	-	-
Double D Service Center	Ada	0.5	-	-	-	-	-
Cloverdale Funeral Home	Ada	0.4	3.0	0.4	0.0	0.1	-
Superior Steel Products, Inc.	Canyon	0.2	-	-	5.0	-	-
EPSCO Corp.	Ada	0.1	0.1	0.0	43.4	0.0	-
Fiberglass Systems	Ada	0.1	-	-	332.5	-	-
Fabrieka International Co.	Ada	0.1	1.2	0.0	0.5	0.8	0.0
Dehryl A. Dennis Professional Technical Center	Ada	0.1	-	-	2.1	-	-
Concrete Placing Co., Inc. Portable Concrete Batch	Ada	0.1	2.2	0.3	0.1	0.5	-
Great American Appetizers	Canyon	0.1	0.9	0.0	0.6	0.8	0.0
Gem State Mfg., Inc.	Canyon	0.0	-	-	19.0	-	-
Western Idaho Cabinets, Inc.	Ada	0.0	-	-	0.7	-	-
YMC Mechanical, Inc.	Ada	0.0	-	-	0.2	-	-
GW International	Canyon	0.0	0.0	0.0	0.0	0.1	0.0
Summers Funeral Home	Ada	0.0	2.5	0.3	0.0	0.1	0.0
Sports Fiberglass, Inc.	Canyon	0.0	-	-	2.0	-	-
United Oil	Ada	-	-	-	212.2	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	-	-	-	89.8	-	-
Safety Kleen System, Inc.	Ada	-	-	-	0.3	-	-
Maravia Corporation	Ada	-	-	-	72.5	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	6.9	-	-
Jak's Refinishing Center	Ada	-	-	-	3.1	-	-
Amoco Oil Company - Boise Terminal	Ada	-	-	-	290.1	-	-
Total Emissions (tons/year)		**5,278.9**	**14,937.4**	**7,279.7**	**4,753.8**	**13,206.5**	**1,006.7**
Total Emissions in Ada County (tons/year)		**1,976.4**	**2,930.2**	**1,419.1**	**2,798.3**	**1,861.6**	**16.6**
Total Emissions in Canyon County (tons/year)		**3,302.5**	**12,007.2**	**5,860.5**	**1,955.4**	**11,344.9**	**990.1**

Footnote:
These numbers represent the estimated point source emissions following the procedures described in this chapter.
Emissions for the following facilities were revised for air quality modeling: Nelson Construction (permit was revised), Monroc Cor (permit was revised), C. Wright Construction (permit revising in progress), and Croman Corporation (out of business, but emissions increased to account for emissions trading).

Table 7-3a. Future year point sources episodic single-digit weekday and weekend day emissions by facility (lbs/day): 2010, 2015, and 2020.

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	6,649.4	18,372.7	29,106.3	606.9	43,328.9	3,700.0
Garnet Energy	Canyon	2,516.3	1,260.1	4,459.4	969.6	1,479.2	1,051.2
J.R. Simplot Company - Caldwell	Canyon	1,538.8	704.8	498.8	281.5	755.9	-
Nelson Const. Co.-Amity(777-00208)	Ada	1,520.2	1,520.2	1,520.2	1,520.2	1,520.2	-
Micronpc.com	Canyon	1,125.3	41,661.4	106.2	830.9	12,357.3	464.0
Nampa Paving & Asphalt Co.	Canyon	866.4	247.7	44.0	302.9	1,231.0	-
Rock Contractors, Inc.	Canyon	771.6	287.0	19.0	22.9	61.9	-
Nelson Construction Co.	Canyon	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Pleasant Valley	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Middleton	Canyon	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Flying Wye(777-00226)	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Flying Wye	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Eagle Island	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Diamond	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Amity	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-AD111	Ada	760.1	760.1	760.1	760.1	760.1	-
Monroc-Nampa	Canyon	760.1	760.1	760.1	760.1	760.1	-
Monroc-Boise Facility	Ada	633.4	633.4	633.4	633.4	633.4	-
Monroc Concrete	Ada	633.4	633.4	633.4	633.4	633.4	-
Can-Ada Crushing	Ada	552.9	1,028.8	96.7	67.9	235.2	-
Castle Wood Products	Ada	515.5	123.5	8.1	10.1	26.6	-
Turner Sand and Gravel-Boise	Ada	451.8	-	-	-	-	-
Simplot-Wst.Stock.	Canyon	371.2	35.3	0.2	1.9	29.7	-
Builders Masonry Products	Ada	367.6	8.8	0.1	1.1	7.4	0.3
ConAgra Beef Company	Canyon	340.7	285.7	1.7	15.7	240.0	31.6
Woodgrain Millwork	Canyon	334.9	10.5	0.1	7.2	3.3	0.1
Summit Stone	Ada	311.3	737.7	48.5	-	158.8	-
Evans Grain, Feeds & Seed Co.	Canyon	290.0	-	-	-	-	-
Central Paving PRC	Ada	284.9	379.6	25.0	-	81.7	-
Hidden Hollow Landfill	Canyon	277.0	75.5	5.0	110.3	43.9	-
J. R. Simplot Company, Nampa Potato Plant	Canyon	254.8	482.6	2.9	327.6	380.1	12.6
Micron Technology	Ada	241.3	1,257.2	102.5	650.5	689.7	55.7
C. Wright Construction	Ada	232.9	3.3	0.4	6.5	16.5	-
Ruschman Sand and Gravel, Inc.	Ada	232.7	459.2	31.1	37.0	99.3	-
Rambo Crushing Co.	Canyon	217.2	-	-	-	-	-
Boise Cascade Container	Canyon	216.1	29.5	0.6	111.9	77.4	2.9
Clements Concrete	Ada	208.7	-	-	-	-	-
SSI Food Svc	Canyon	189.8	87.8	0.5	4.8	73.8	2.8
Central Paving, Inc. #2	Ada	182.2	12.8	51.2	10.9	13.9	-
Prime Earth	Ada	162.5	186.0	12.2	15.5	41.0	-
Nelson-Deppe Inc. - Ada	Ada	149.3	766.4	50.4	-	165.0	-
Central Paving, Inc. #1	Ada	146.5	351.9	25.7	165.3	613.3	-
IBP	Ada	146.1	505.3	656.9	49.9	221.5	12.5

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
Low's Ready Mix, Inc. - Star West Facility	Canyon	141.3	85.9	5.6	7.0	118.4	-
Syngenta Seeds, Inc.-Nampa Plant	Canyon	141.2	16.5	0.1	0.3	2.4	-
Sorrento Lactalis	Canyon	140.5	65.1	0.8	7.0	107.4	0.6
Nelson-Deppe Inc. - Canyon	Canyon	140.0	718.5	47.2	-	154.7	-
Sawtooth Forest Products	Canyon	131.2	-	-	-	-	-
Chevron Pipeline Boise	Ada	130.2	9.6	0.0	1,316.3	3.6	-
Snake River Chemicals, Inc.	Canyon	127.7	0.2	0.0	0.0	0.0	-
Mike's Sand and Gravel	Ada	126.6	-	-	-	-	-
Idaho Sand & Gravel	Canyon	113.2	232.2	244.9	135.1	633.4	-
Unaga-Eusti Enterprises, Inc. (G&B Redi)-Star Pit	Canyon	110.7	81.4	1.3	2.5	21.5	-
Quality Sand & Gravel	Ada	110.3	78.6	5.2	8.7	16.9	-
Pacific Press Publishing Association	Canyon	101.0	73.2	2.2	144.0	17.7	0.0
Plum Creek Northwest Lumber, Inc.	Ada	99.8	-	-	-	-	-
Westfarm Foods-Caldwell	Canyon	95.0	151.1	0.9	11.3	105.9	40.5
Centerlane Paving, LLC	Ada	94.7	2,013.1	991.3	302.3	1,108.7	-
Consolidated Concrete Company Aspen Road Facility	Ada	93.4	-	-	-	-	-
Croman Corporation	Ada	91.8	110.8	0.5	4.4	66.4	2.5
Idaho Asphalt	Canyon	89.8	112.3	0.7	154.8	64.4	3.6
Western World, Inc. Circle J Trailers	Canyon	89.6	-	-	-	-	-
Bowman Sand and Gravel	Canyon	85.5	427.7	28.1	35.3	92.1	-
Canyon Sand and Gravel, Inc.	Canyon	78.3	533.3	86.9	15.5	146.2	-
Trus Joist Product Development Center	Ada	74.1	-	-	-	-	-
Darling International Inc.	Ada	67.0	139.5	4.5	27.2	124.7	7.9
Fleetwood Homes	Canyon	64.5	-	-	256.8	-	-
Capital Paving Company	Ada	60.4	0.2	0.0	14.9	5.4	-
Low's Ready Mix, Eagle	Ada	49.3	-	-	-	-	-
Jabil Circuit	Ada	47.3	1.7	0.2	115.4	1.2	-
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	44.7	0.8	2.2	17.2	0.2	0.0
White's Hauling & Farm	Canyon	44.2	-	-	-	-	-
American Paving Company	Ada	41.6	49.4	9.9	28.7	116.8	-
Crookham	Canyon	35.8	19.3	0.1	1.1	16.2	0.6
Simplot AgriSource - Nampa	Canyon	34.1	-	-	-	-	-
Idaho Air National Guard	Ada	33.8	380.2	6.0	141.9	269.7	0.0
West Boise WWTF	Ada	32.4	671.6	57.2	24.9	141.3	10.4
Northwest Pipeline	Ada	31.7	1,722.0	67.2	50.5	645.5	-
Seminis Veg. Seeds	Canyon	29.6	112.7	0.7	6.2	94.7	3.6
Western Construction-Crusher #00042	Canyon	27.5	8.1	0.6	0.2	2.2	-
Motivepower, Inc. Apple Street	Ada	25.9	24.1	0.1	345.1	20.3	-
Motivepower, Inc., Branniff Street	Ada	23.4	926.8	61.9	82.2	212.9	0.1
Idaho Concrete Company	Canyon	22.6	-	-	-	-	-
LP Wood Polymers, Inc.	Ada	19.1	17.0	-	15.9	6.6	-
Zamzow's Feed Mill	Ada	15.7	0.5	0.0	0.0	0.4	0.0
Hewlett Packard Company	Ada	14.5	206.3	13.5	249.6	46.5	0.1
Koch Materials Company	Ada	14.3	111.6	349.9	427.5	27.3	2.5
Lander St. WWTF	Ada	12.2	327.7	62.0	22.8	88.6	1.6
Western Electronics LLC	Ada	9.6	17.7	-	6.7	3.8	-

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
Boise Airport	Ada	9.5	2.0	0.1	8.7	0.4	0.0
Riverside Crematory	Ada	6.6	45.0	6.0	0.7	1.3	-
Teton Sales Company	Canyon	6.6	2.1	0.0	1,699.9	0.9	-
Zilog, Inc.	Canyon	5.6	127.9	11.0	194.9	68.6	109.9
Idaho Truss & Component Company	Ada	5.1	-	-	-	-	-
Atlas Pallet Co.	Canyon	4.8	-	-	-	-	-
Zilog Inc.	Canyon	4.6	108.5	9.9	194.0	56.2	20.8
Monroc-Middleton	Canyon	4.0	-	-	-	-	-
Double D Service Center	Ada	3.8	-	-	-	-	-
Westfarm Foods-Boise	Ada	3.8	25.1	2.9	3.3	42.2	1.6
MCMS, Inc.	Canyon	3.8	25.5	0.2	2,300.0	17.3	0.5
Cloverdale Funeral Home	Ada	3.4	22.9	3.0	0.3	0.7	-
Harris Moran Seed Co.	Canyon	3.2	10.6	0.1	1.2	17.7	-
Clayton's Calcium, Inc.	Ada	2.8	-	-	-	-	-
Alden's Inc. Waggoner Funeral Chapel	Ada	2.4	0.2	0.2	3.6	3.8	-
Concrete Placing Co., Inc. Portable Concrete Batch	Ada	1.2	63.0	7.0	2.0	14.0	-
EPSCO Corp.	Ada	1.1	0.6	0.0	333.5	0.1	-
Superior Steel Products, Inc.	Canyon	0.8	-	-	27.6	-	-
Great American Appetizers	Canyon	0.7	8.6	0.1	5.8	7.3	0.3
Fabrieka International Co.	Ada	0.6	9.1	0.1	2.7	5.9	0.0
Fiberglass Systems	Ada	0.4	-	-	2,552.8	-	-
Dehryl A. Dennis Professional Technical Center	Ada	0.4	-	-	11.6	-	-
Gem State Mfg., Inc.	Canyon	0.3	-	-	104.3	-	-
Western Idaho Cabinets, Inc.	Ada	0.2	-	-	5.2	-	-
YMC Mechanical, Inc.	Ada	0.1	-	-	1.1	-	-
GW International	Canyon	0.1	0.1	0.0	0.0	0.7	0.0
Summers Funeral Home	Ada	0.1	13.8	1.8	0.3	0.4	0.0
Sports Fiberglass, Inc.	Canyon	0.0	-	-	11.1	-	-
United Oil	Ada	-	-	-	1,162.7	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	-	-	-	492.5	-	-
Safety Kleen System, Inc.	Ada	-	-	-	1.7	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	37.6	-	-
Jak's Refinishing Center	Ada	-	-	-	17.2	-	-
Amoco Oil Company - Boise Terminal	Ada	-	-	-	1,591.0	-	-
Total Emissions (lbs/day)		**33,816.2**	**89,660.5**	**47,835.1**	**29,743.3**	**77,540.9**	**5,541.0**
Total Emissions in Ada County (lbs/day)		**13,654.5**	**20,918.1**	**10,866.7**	**18,535.7**	**13,452.6**	**95.2**
Total Emissions in Canyon County (lbs/day)		**20,161.7**	**68,742.3**	**36,968.4**	**11,207.6**	**64,088.3**	**5,445.8**

Footnote:
These numbers represent the estimated point source emissions following the procedures described in this chapter.
Emissions for the following facilities were revised for air quality modeling: Nelson Construction (permit was revised), Monroc Conc (permit was revised), C. Wright Construction (permit revising in progress), and Croman Corporation (out of business, but emissions increased to account for emissions trading).

Table 7-3b. Future year point sources episodic double-digit weekday emissions by facility (lbs/day): 2010, 2015, and 2020.

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
The Amalgamated Sugar Company LLC - Nampa Factory	Canyon	6,552.9	18,372.7	29,106.3	606.9	43,328.9	3,700.0
Garnet Energy	Canyon	2,516.3	1,260.1	4,459.4	969.6	1,479.2	1,051.2
J.R. Simplot Company - Caldwell	Canyon	1,526.3	704.8	498.8	281.5	755.9	-
Nelson Const. Co.-Amity(777-00208)	Ada	1,520.2	1,520.2	1,520.2	1,520.2	1,520.2	-
Micronpc.com	Canyon	1,125.3	41,661.4	106.2	830.9	12,357.3	464.0
Nampa Paving & Asphalt Co.	Canyon	860.4	247.7	44.0	302.9	1,231.0	-
Nelson Const. Co.-AD111	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Amity	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Diamond	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Eagle Island	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Flying Wye	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Flying Wye(777-00226)	Ada	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Pleasant Valley	Ada	760.1	760.1	760.1	760.1	760.1	-
Monroc-Nampa	Canyon	760.1	760.1	760.1	760.1	760.1	-
Nelson Const. Co.-Middleton	Canyon	760.1	760.1	760.1	760.1	760.1	-
Nelson Construction Co.	Canyon	760.1	760.1	760.1	760.1	760.1	-
Rock Contractors, Inc.	Canyon	745.1	287.0	19.0	22.9	61.9	-
Monroc Concrete	Ada	633.4	633.4	633.4	633.4	633.4	-
Monroc-Boise Facility	Ada	633.4	633.4	633.4	633.4	633.4	-
Castle Wood Products	Ada	515.5	123.5	8.1	10.1	26.6	-
Can-Ada Crushing	Ada	425.3	1,028.8	96.7	67.9	235.2	-
Simplot-Wst.Stock.	Canyon	357.0	35.3	0.2	1.9	29.7	-
Turner Sand and Gravel-Boise	Ada	334.1	-	-	-	-	-
Builders Masonry Products	Ada	332.6	8.8	0.1	1.1	7.4	0.3
Woodgrain Millwork	Canyon	313.3	10.5	0.1	7.2	3.3	0.1
Evans Grain, Feeds & Seed Co.	Canyon	290.0	-	-	-	-	-
J. R. Simplot Company, Nampa Potato Plant	Canyon	254.0	482.6	2.9	327.6	380.1	12.6
Micron Technology	Ada	216.9	1,257.2	102.5	650.5	689.7	55.7
Boise Cascade Container	Canyon	215.1	29.5	0.6	111.9	77.4	2.9
Clements Concrete	Ada	202.2	-	-	-	-	-
Rambo Crushing Co.	Canyon	187.7	-	-	-	-	-
SSI Food Svc	Canyon	182.3	87.8	0.5	4.8	73.8	2.8
Prime Earth	Ada	162.2	186.0	12.2	15.5	41.0	-
C. Wright Construction	Ada	144.6	3.3	0.4	6.5	16.5	-
Syngenta Seeds, Inc.-Nampa Plant	Canyon	141.2	16.5	0.1	0.3	2.4	-
Nelson-Deppe Inc. - Ada	Ada	137.3	766.4	50.4	-	165.0	-
Sawtooth Forest Products	Canyon	131.2	-	-	-	-	-
Sorrento Lactalis	Canyon	127.7	65.1	0.8	7.0	107.4	0.6
IBP	Ada	127.7	505.3	656.9	49.9	221.5	12.5
Snake River Chemicals, Inc.	Canyon	127.7	0.2	0.0	0.0	0.0	-
Low's Ready Mix, Inc. - Star West Facility	Canyon	107.2	85.9	5.6	7.0	118.4	-
Nelson-Deppe Inc. - Canyon	Canyon	102.9	718.5	47.2	-	154.7	-
Pacific Press Publishing Association	Canyon	101.0	73.2	2.2	144.0	17.7	0.0

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
Idaho Sand & Gravel	Canyon	97.1	232.2	244.9	135.1	633.4	-
Westfarm Foods-Caldwell	Canyon	95.0	151.1	0.9	11.3	105.9	40.5
Plum Creek Northwest Lumber, Inc.	Ada	90.6	-	-	-	-	-
Western World, Inc. Circle J Trailers	Canyon	89.6	-	-	-	-	-
Quality Sand & Gravel	Ada	87.2	78.6	5.2	8.7	16.9	-
Central Paving PRC	Ada	86.2	379.6	25.0	-	81.7	-
Bowman Sand and Gravel	Canyon	79.7	427.7	28.1	35.3	92.1	-
Croman Corporation	Ada	76.4	110.8	0.5	4.4	66.4	2.5
Hidden Hollow Landfill	Canyon	76.3	75.5	5.0	110.3	43.9	-
Darling International Inc.	Ada	67.0	139.5	4.5	27.2	124.7	7.9
Fleetwood Homes	Canyon	64.5	-	-	256.8	-	-
Ruschman Sand and Gravel, Inc.	Ada	63.1	459.2	31.1	37.0	99.3	-
Summit Stone	Ada	59.9	737.7	48.5	-	158.8	-
Centerlane Paving, LLC	Ada	53.8	2,013.1	991.3	302.3	1,108.7	-
Canyon Sand and Gravel, Inc.	Canyon	51.0	533.3	86.9	15.5	146.2	-
Trus Joist Product Development Center	Ada	47.4	-	-	-	-	-
Unaga-Eusti Enterprises, Inc. (G&B Redi)-Star Pit	Canyon	47.3	81.4	1.3	2.5	21.5	-
Jabil Circuit	Ada	47.3	1.7	0.2	115.4	1.2	-
Low's Ready Mix, Eagle	Ada	47.0	-	-	-	-	-
White's Hauling & Farm	Canyon	44.2	-	-	-	-	-
Idaho Air National Guard	Ada	33.8	380.2	6.0	141.9	269.7	0.0
Consolidated Concrete Company Aspen Road Facility	Ada	32.6	-	-	-	-	-
Central Paving, Inc. #1	Ada	32.4	351.9	25.7	165.3	613.3	-
Simplot AgriSource - Nampa	Canyon	32.0	-	-	-	-	-
West Boise WWTF	Ada	31.9	671.6	57.2	24.9	141.3	10.4
Northwest Pipeline	Ada	31.7	1,722.0	67.2	50.5	645.5	-
Seminis Veg. Seeds	Canyon	28.0	112.7	0.7	6.2	94.7	3.6
ConAgra Beef Company	Canyon	27.6	285.7	1.7	15.7	240.0	31.6
Motivepower, Inc. Apple Street	Ada	25.6	24.1	0.1	345.1	20.3	-
Mike's Sand and Gravel	Ada	24.9	-	-	-	-	-
Capital Paving Company	Ada	23.6	0.2	0.0	14.9	5.4	-
Motivepower, Inc., Branniff Street	Ada	23.4	926.8	61.9	82.2	212.9	0.1
Western Construction-Crusher #00042	Canyon	21.2	8.1	0.6	0.2	2.2	-
American Paving Company	Ada	20.8	49.4	9.9	28.7	116.8	-
Crookham	Canyon	20.6	19.3	0.1	1.1	16.2	0.6
LP Wood Polymers, Inc.	Ada	19.1	17.0	-	15.9	6.6	-
Zamzow's Feed Mill	Ada	15.7	0.5	0.0	0.0	0.4	0.0
Hewlett Packard Company	Ada	14.5	206.3	13.5	249.6	46.5	0.1
Lander St. WWTF	Ada	12.1	327.7	62.0	22.8	88.6	1.6
Koch Materials Company	Ada	11.5	111.6	349.9	427.5	27.3	2.5
Western Electronics LLC	Ada	9.6	17.7	-	6.7	3.8	-
Idaho Asphalt	Canyon	8.5	112.3	0.7	154.8	64.4	3.6
Central Paving, Inc. #2	Ada	8.5	12.8	51.2	10.9	13.9	-
Idaho Concrete Company	Canyon	7.3	-	-	-	-	-
Riverside Crematory	Ada	6.6	45.0	6.0	0.7	1.3	-
Teton Sales Company	Canyon	6.6	2.1	0.0	1,699.9	0.9	-

Facility Name	County	PM10	NOx	SOx	VOC	CO	NH3
Zilog, Inc.	Canyon	5.6	127.9	11.0	194.9	68.6	109.9
Atlas Pallet Co.	Canyon	4.8	-	-	-	-	-
Zilog Inc.	Canyon	4.6	108.5	9.9	194.0	56.2	20.8
Double D Service Center	Ada	3.8	-	-	-	-	-
Westfarm Foods-Boise	Ada	3.8	25.1	2.9	3.3	42.2	1.6
Cloverdale Funeral Home	Ada	3.4	22.9	3.0	0.3	0.7	-
Harris Moran Seed Co.	Canyon	3.2	10.6	0.1	1.2	17.7	-
Alden's Inc. Waggoner Funeral Chapel	Ada	2.4	0.2	0.2	3.6	3.8	-
Idaho Truss & Component Company	Ada	2.3	-	-	-	-	-
EPSCO Corp.	Ada	1.1	0.6	0.0	333.5	0.1	-
Concrete Placing Co., Inc. Portable Concrete Batch	Ada	1.0	63.0	7.0	2.0	14.0	-
Superior Steel Products, Inc.	Canyon	0.8	-	-	27.6	-	-
MCMS, Inc.	Canyon	0.8	25.5	0.2	2,300.0	17.3	0.5
Great American Appetizers	Canyon	0.7	8.6	0.1	5.8	7.3	0.3
Fabrieka International Co.	Ada	0.6	9.1	0.1	2.7	5.9	0.0
Dehryl A. Dennis Professional Technical Center	Ada	0.4	-	-	11.6	-	-
Chevron Pipeline Boise	Ada	0.3	9.6	0.0	1,316.3	3.6	-
Gem State Mfg., Inc.	Canyon	0.3	-	-	104.3	-	-
Western Idaho Cabinets, Inc.	Ada	0.2	-	-	5.2	-	-
Boise Airport	Ada	0.1	2.0	0.1	8.7	0.4	0.0
YMC Mechanical, Inc.	Ada	0.1	-	-	1.1	-	-
Clayton's Calcium, Inc.	Ada	0.1	-	-	-	-	-
GW International	Canyon	0.1	0.1	0.0	0.0	0.7	0.0
Summers Funeral Home	Ada	0.1	13.8	1.8	0.3	0.4	0.0
Unaga-Eusti Enterprises, Inc (G & B Redi-mix)	Canyon	0.0	0.8	2.2	17.2	0.2	0.0
Sports Fiberglass, Inc.	Canyon	0.0	-	-	11.1	-	-
Amoco Oil Company - Boise Terminal	Ada	-	-	-	1,591.0	-	-
Fiberglass Systems	Ada	-	-	-	2,552.8	-	-
Jak's Refinishing Center	Ada	-	-	-	17.2	-	-
Lynn Research & Technology, Inc.	Ada	-	-	-	37.6	-	-
Safety Kleen System, Inc.	Ada	-	-	-	1.7	-	-
Sinclair Oil Corp.-Boise Terminal	Ada	-	-	-	492.5	-	-
United Oil	Ada	-	-	-	1,162.7	-	-
Monroc-Middleton	Canyon	-	-	-	-	-	-
Total Emissions (lbs/day)		**30,892.1**	**89,660.5**	**47,835.1**	**29,743.3**	**77,540.9**	**5,541.0**
Total Emissions in Ada County (lbs/day)		**11,829.6**	**20,918.1**	**10,866.7**	**18,535.7**	**13,452.6**	**95.2**
Total Emissions in Canyon County (lbs/day)		**19,062.4**	**68,742.3**	**36,968.4**	**11,207.6**	**64,088.3**	**5,445.8**

Footnote:
These numbers represent the estimated point source emissions following the procedures described in this chapter.
Emissions for the following facilities were revised for air quality modeling: Nelson Construction (permit was revised), Monroc (permit was revised), C. Wright Construction (permit revising in progress), and Croman Corporation (out of business, but emissions increased to account for emissions trading).

8.0 FUTURE YEAR AREA SOURCES

The area source inventory for future years includes the six pollutants estimated for the 1999 base year (i.e., PM_{10}, NO_x, SO_x, NH_3, VOC, and CO) projected forward to the years of 2010, 2015, and 2020. The projected emissions were estimated by applying a growth factor and a control factor to the 1999 base year emission estimates. Episodic daily emissions were also developed for these three future years. Details regarding the future year area sources data collection, emission estimation methodology, and QA/QC procedures are discussed in the remainder of this section.

8.1 DATA COLLECTION AND METHODOLOGY

The future year inventories were developed according to the methodology and quality assurance/quality check (QA/QC) procedure described in *Final Inventory Preparation Plan/Quality Assurance Plan (IPP/QAP)* (ENVIRON, 2001).

In general, the methodology used to project the area source emissions inventory to the future years was as follows:

1. Develop growth factors using data such as population, number of households, agricultural acreage, livestock population, etc.
2. Develop control factors using data such as regulatory VOC reductions, anticipated number of voluntary and mandatory burn bans days applicable to residential wood combustion, etc.
3. Apply growth and control factors to base year (1999) annual emissions to estimate future year (2010, 2015, and 2020) annual emissions (tons/year).
4. Determine effects of 1991 meteorological conditions (e.g., temperature) and develop single- and double-digit weekday and weekend day (episode) adjustment factors.
5. Calculate average daily emissions (i.e., [annual emissions from step 3]/365).
6. Apply episode adjustment factors to average daily (for 2010, 2015, and 2020) emissions to estimate future year episode emissions for single- and double-digit weekdays and weekend days.

Each of these steps is described in more detail below.

8.1.1 Growth Factor Development

The sources of growth factor data used to project future year area source emissions are summarized in Table 8-1; the data for these growth factors are provided in Table 8-2. Most of the growth factors used for projecting area sources were based upon demographic projections provided by the Community Planning Association of Southwest Idaho (COMPASS) (COMPASS, 2001). The COMPASS demographic projections included population, household, VMT, and employment (i.e., retail, office, industrial, government, agricultural). Based on the employment projections, two other employment projections were derived that more accurately corresponded to the emission source categories: total (i.e., the sum of all five employment types) and commercial (i.e., the sum of retail, office, and government). The population, household, and VMT projections were based on a 1999 base year with projected values for the 2010, 2015, and 2020 future years. The employment projections were based on a 2000 base year with projected values for the 2010, 2015, and 2020 future years. It was assumed that 2000 employment was equivalent to 1999 employment (i.e., 2000 employment was not backcasted to 1999).

Table 8-1. Area source growth and control factors.

Source Category	Basis for Growth Factor	Source of Growth Factor Data	Basis for Control Factor	Source of Control Factor Information
Residential Wood Combustion (Fireplaces)	Households	COMPASS, 2001	Burn bans	Dong, 2002; Hendrickson, 2002; IDEQ, 1991
Residential Wood Combustion (Woodstoves)	Households	COMPASS, 2001	Burn bans	Dong, 2002; Hendrickson, 2002; IDEQ, 1991
Other Fuel Combustion – Natural Gas (Industrial)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Natural Gas (Comm./Inst.)	Commercial Employment	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Natural Gas (Residential)	Households	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Propane (Industrial)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Propane (Comm./Inst.)	Commercial Employment	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Propane (Residential)	Households	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Distillate (Industrial)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Distillate (Comm./Inst.)	Commercial Employment	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Distillate (Residential)	Households	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Residual (Industrial)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Residual (Comm./Inst.)	Commercial Employment	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Residual (Residential)	Households	COMPASS, 2001	None	Not Applicable
Other Fuel Combustion – Coal	Households	COMPASS, 2001	None	Not Applicable
Open Burning – Residential Municipal Solid Waste	Population (non-Boise)	COMPASS, 2001	None	Not Applicable
Open Burning – Yard Waste	Population (non-Boise)	COMPASS, 2001	None	Not Applicable
Open Burning – Agricultural Fields	Agricultural Land Use Trends	Belzer, 2002	None	Not Applicable
Open Burning – Ditches	Agricultural Land Use Trends	Belzer, 2002	None	Not Applicable
Open Burning – Prescribed	Unchanged	Not Applicable	None	Not Applicable
Other Fires – Structural	Households	COMPASS, 2001	None	Not Applicable
Other Fires – Vehicle	VMT	COMPASS, 2001	None	Not Applicable
Other Fires – Wildfires	Unchanged	Not Applicable	None	Not Applicable
Agricultural Windblown	Agricultural	Belzer, 2002	None	Not Applicable

Source Category	Basis for Growth Factor	Source of Growth Factor Data	Basis for Control Factor	Source of Control Factor Information
Dust	Land Use Trends			
Fugitive Dust (Tillage)	Agricultural Land Use Trends	Belzer, 2002	None	Not Applicable
Fugitive Dust (Harvest)	Agricultural Land Use Trends	Belzer, 2002	None	Not Applicable
Fugitive Dust (Feedlots)	Unchanged	Not Applicable	None	Not Applicable
Fugitive Dust (Construction Activities)	Population	COMPASS, 2001	None	Not Applicable
Fugitive Dust (Wind Erosion of Natural Habitat)	Unchanged	Not Applicable	None	Not Applicable
Livestock Ammonia	Unchanged	Not Applicable	None	Not Applicable
Fertilizer Ammonia	Agricultural Land Use Trends	Belzer, 2002	None	Not Applicable
Cold Storage Ammonia	Industrial Employment	COMPASS, 2001	None	Not Applicable
Biogenic Emissions	Unchanged	Not Applicable	None	Not Applicable
Gasoline Distribution (Stage I)	VMT	COMPASS, 2001	None	Not Applicable
Gasoline Distribution (Stage II)	VMT	COMPASS, 2001		
Gasoline Distribution (Underground Tank)	VMT	COMPASS, 2001	None	Not Applicable
Gasoline Distribution (Tank Truck Transit)	VMT	COMPASS, 2001	None	Not Applicable
Aviation Refueling	BEA	BEA, 2001	None	Not Applicable
Autobody Refinishing	Industrial Employment	COMPASS, 2001	National VOC Rule	Federal Register, 1998a
Architectural Surface Coating	Population	COMPASS, 2001	National VOC Rule	Federal Register, 1998b
Dry Cleaning	Population	COMPASS, 2001	None	Not Applicable
Consumer Solvent Use	Population	COMPASS, 2001	National VOC Rule	Federal Register, 1998c
Degreasing (Cold Cleaning – Automobile Repair)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Degreasing (Cold Cleaning – Manufacturing)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Degreasing (Vapor and In-Line Cleaning – Electronics and Electrical)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Degreasing (Vapor and In-Line Cleaning – Other)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Graphic Arts	Population	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating (Factory Finished Wood)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating (Wood Furniture)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating (Miscellaneous Finished Metals)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating	Industrial	COMPASS, 2001	None	Not Applicable

Source Category	Basis for Growth Factor	Source of Growth Factor Data	Basis for Control Factor	Source of Control Factor Information
(Machinery and Equipment)	Employment			
Industrial Surface Coating (Motor Vehicles)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating (Marine)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating (Railroad)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating (Miscellaneous Manufacturing)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating (Industrial Maintenance Coatings)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Industrial Surface Coating (Other Special Purpose Coatings)	Industrial Employment	COMPASS, 2001	None	Not Applicable
Pesticide Application	Agricultural Land Use Trends	Belzer, 2002	None	Not Applicable
Traffic Markings	Population	COMPASS, 2001	None	Not Applicable
Asphalt Paving	Population	COMPASS, 2001	None	Not Applicable
Charbroiling	Population	COMPASS, 2001	None	Not Applicable

Table 8-2. Future year growth factors and surrogates for area sources.

Ada County Surrogate	Ada 1999	Ada 2010	Ada 2015	Ada 2020	Growth relative to 1999: 2010	2015	2020
Agricultural land use trends	195,975	193,315	191,985	190,655	0.986	0.980	0.973
BEA-General Aviation	106	162	187	212	1.522	1.759	1.996
Commercial employment	157,475	201,430	221,752	239,426	1.279	1.408	1.520
Households	119,363	150,691	170,170	174,321	1.262	1.426	1.460
Industrial employment	41,546	54,507	60,539	67,965	1.312	1.457	1.636
Population	283,402	402,500	455,171	466,403	1.420	1.606	1.646
Population (non-Boise)	115,032	140,689	163,358	168,325	1.223	1.420	1.463
VMT	6,361,235	8,751,299	10,159,034	11,669,886	1.376	1.597	1.835

Canyon County Surrogate	1999	2010	2015	2020	Growth relative to 1999: 2010	2015	2020
Agricultural land use trends	264,991	256,971	252,961	248,951	0.970	0.955	0.939
BEA-General Aviation	106	162	187	212	1.522	1.759	1.996
Commercial employment	27,686	34,747	38,286	43,391	1.255	1.383	1.567
Households	48,438	57,435	62,343	66,355	1.186	1.287	1.370
Industrial employment	15,609	17,395	18,294	19,191	1.114	1.172	1.229
Population	124,442	167,416	181,313	192,738	1.345	1.457	1.549
Population (non-Boise)	124,442	167,416	181,313	192,738	1.345	1.457	1.549
VMT	2,417,727	3,193,374	3,625,893	4,138,348	1.321	1.500	1.712

Although the growth factors were primarily developed using COMPASS demographic projections, a few specialized growth factors using other sources of information were developed. The growth of agricultural sources (i.e., agricultural burning, ditch burning, agricultural windblown dust, tillage, harvest activities, fertilizer application, and pesticide application) was projected based upon agricultural land use trends. Due to development pressures in Ada and Canyon County, agricultural acreage is projected to decrease in the future. Projected agricultural acreage in 2020 was provided by analysts working on the Treasure Valley Future project (Belzer, 2002). Ada County agricultural acreage in 2020 was projected to be 97.3 percent of the 1999 acreage; Canyon County agricultural acreage in 2020 was projected to 93.9 percent of the 1999 acreage. Straight-line interpolation was used to calculated growth factors for the 2010 and 2015 future years.

Anecdotal information indicated that prescribed burning in the Western United States could increase significantly in the future in an effort to reduce fuel loadings on federally-managed lands. However, BLM land managers responsible for land within Ada and Canyon County indicated that their prescribed burning is primarily for weed control and that their agency does not anticipate an increase in prescribed burning activity in the future (Thomas, 2002). Therefore, it was assumed that future year prescribed burning emissions would be unchanged relative to the 1999 base year emissions.

The growth factor for aviation refueling was derived from the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) projection information (BEA, 2001). In general, locally developed projection data are preferred over the national-level projection information developed by BEA. However, none of the COMPASS demographic projections were appropriate for the aviation refueling source category.

Future livestock trend information could not be identified, so livestock-based growth factors were not developed for livestock-related source categories (i.e., beef cattle feedlots and livestock ammonia) and future year emissions were assumed to be identical to the 1999 base year emissions. Also, no basis could be determined for calculating future year growth of natural-type area sources (i.e., wildfires, wind erosion of natural habitat, and biogenic emissions), so these future year emissions were also assumed to be identical to the 1999 base year emissions.

8.1.2 Control Factor Development

Applicable future year controls were only identified for a few area source categories. The sources of control factor data used to project future year area source emissions are also summarized in Table 8-1.

Voluntary and mandatory burn ban regulations exist in Ada and Canyon County that are applicable to both residential wood combustion and residential open burning. It is assumed that voluntary and mandatory burn bans do not provide any annual emission reductions because burns can be shifted to non-burn ban days.

The level of residential wood combustion annual emission reductions was estimated based upon the average annual number of days with PM_{10} concentrations in the following ranges:

- 70-99 $\mu g/m^3$; and
- 100-149 $\mu g/m^3$.

On average, there are 6 days per year with PM_{10} concentrations between 70-99 $\mu g/m^3$ and 2 days per year with PM_{10} concentrations between 100-149 $\mu g/m^3$ in the Ada and Canyon County area (Dong, 2002). Based upon existing and future regulations, this corresponds to 6 days of voluntary bans and 2 days mandatory bans in Ada County and 8 days of voluntary bans in Canyon County (Hendrickson, 2002). An annual weighted average was calculated using approved emission reductions previously identified in the 1991 SIP (IDEQ, 1991).

Three VOC area source categories (i.e., autobody refinishing, consumer solvents, and architectural coatings) are subject to future controls due to national VOC rules. The regulations identified a 33 percent emissions reduction for autobody refinishing and a 20 percent emissions reduction for architectural coatings and consumer solvents (Federal Register, 1998a; Federal Register, 1998b; Federal Register, 1998c). The phase-in for these national VOC rules was occurring during 1999. However, it was difficult to assess the level of phase-in for the 1999 base year emissions. Therefore, it was assumed that these VOC rules were not in effect during the 1999 base year and that they were entirely implemented for the future years.

Finally, Stage II vehicle refueling emissions are expected to decrease in the future. Control factors were estimated by ratioing future year MOBILE6 emission factors by base year emission factors (U.S. EPA, 2001).

Discussions with IDEQ staff indicated that there currently is not any projected state-level rule-making that would impact future year emissions contained in the Ada and Canyon County inventory (Gradwohl, 2002). Further research did not identify any other future control reductions that would affect area source categories.

8.1.3 Calculation of Future Year Emissions

Emissions for the 2010, 2015, and 2020 future year inventories were calculated using the following equation:

$$E_{FY} = E_{BY} \times G \times (1 - C)$$

where:

E_{FY} = Future year emissions (tons/year);
E_{BY} = Base year emissions (tons/year);
G = Growth factor; and
C = Control factor.

Growth factors were expressed as the ratio of future year emissions/activity to base year emissions/activity (i.e., a 15 percent increase in emissions would correspond to a growth factor of 1.15). Control factors were expressed as the level of control that would be applied to the uncontrolled base year emissions (i.e., emission reductions of 20 percent would correspond to a control factor of 0.20).

A sample calculation using this equation for estimating VOC emissions in 2010 from Ada County consumer solvent use is as follows:

where:
E_{BY} = 1,110.9 tons/year;
G = 1.420;
C = 0.200; and
E_{FY} = 1,262.2 tons/year.

8.1.4 Episode Adjustment Factors

After annual emission estimates were calculated for the future years of 2010, 2015, and 2020 for Ada and Canyon County area sources, daily episode emission estimates were then calculated for each of these three future years. The calculation methods are similar to those used in calculating the 1999 base year daily episode emissions (see Section 3.3). However, the future year episodes are not based upon the December 20-26, 1999 meteorological conditions. Instead, the future year episodes are based upon meteorological conditions that occurred during the January 1-11, 1991 episode. The base year daily episodes were for weekdays and weekend days. The future year daily episodes were for "single-digit weekdays" (i.e., conditions similar to weekdays with single-digit average temperatures – January 1-4, 1991), "double-digit weekdays" (i.e. conditions similar to weekdays with double-digit average temperatures – January 7-11, 1991), and weekend days (i.e., conditions similar to January 5-6, 1991).

The identification of those sources active during the future year episodes were conducted in the same way as the base year episode (see Sections 3.3.1 and 3.3.2). The only difference was that sources that were active during the base year weekday episode were assumed to be active for both the future year single-digit weekday and double-digit weekday episodes.

In general, future year daily episode emissions were estimated the same way as the base year episode emissions were (See Section 3.3.3). For example, many future year daily episode emissions were defined as being equal to the average daily emissions (i.e., future year annual emissions divided by 365). Also, future year daily episode emissions for the other fuel combustion area source categories used the same adjustment factor as the base year daily episode emissions. Future year daily episode Stage II vehicle refueling emissions were calculated using an adjustment factor based upon future year annual average and winter average refueling emission factors. The only significant exception to the methodology used to estimate future year daily episode emissions was for the residential wood combustion (fireplaces and woodstoves) area source category.

Future year biogenic VOC and NOx emission estimates set to the 1999 biogenic estimates from PC-BEIS for December 24 for all days of the January 1991 meteorological episode (as described in Section 3.3.3.4). The 1999 biogenic emissions estimates were quite low for all counties because of the season and the cold, often cloud-covered conditions during the December 1999 period. Given the insignificant contribution of biogenics in such conditions, and the fact that the January 1991 period was even colder and snow-covered, December 24 best represented the average diurnal temperature range and cloud conditions over the January 1991 episode.

The future year daily episode emissions were also estimated using the three adjustment described in Section 3.3.3.1 (i.e., adjust average monthly device usage to December monthly device usage, adjust average daily wood consumption to average weekday and weekend day daily wood consumption, and adjust December 1996 heating degree days [HDD] to December 1999). It should be noted that the adjustment of average daily wood consumption to average weekday and weekend day daily wood consumption for future years was developed using the traditional week of five weekdays and two weekend days.

Two additional adjustment factors were used to estimate future year daily episode emissions. First of all, another HDD adjustment factor was developed to account for the meteorological differences between December 1999 and January 1991 (INSIDE, 2001). Also, an additional adjustment factor was developed to account for a new woodburning stove survey that was completed in 2001 (Tarnai, 2001). This new survey was identified after the 1999 base year inventory was completed. However, some of the findings in this survey related to device populations were applicable to future year daily episode emissions. The second adjustment factor accounts for these findings.

8.2 EMISSIONS BY SOURCE CATEGORY

Tables 8-3 and 8-4 contain the results of the future year area source emissions inventory for Ada and Canyon counties.

Tables 8-3a and 8-3b summarize the annual emissions (tons) for Ada and Canyon counties, respectively, for the years 2010, 2015, and 2020, by source category. In both counties, emissions of all pollutants increased relative to 1999 emissions, except for NH_3 (both counties) and PM_{10} (Canyon county). These decreases in NH_3 and PM_{10} are due mainly to the anticipated decrease in agricultural activity in the future in both counties. PM_{10} emissions are predicted to increase in the future in Ada county (i.e., 22% overall between 1999 and 2020) due mainly to increases in emissions from residential fuel combustion and construction fugitive dust.

Tables 8-4a through 8-4c show the results of the projected daily emissions for the three day types (i.e., single-digit weekday, double-digit weekend day, and weekend day) in Ada County for the years 2010, 2015, and 2020, respectively, by source category and pollutant. Tables 8-4d through 8-4f show the results of the projected daily emissions for the three day types in Canyon County for the years 2010, 2015, and 2020, respectively, by source category and pollutant. These future year episodes are based on 1991 meteorology for each of the three day types. Note that the projected daily emissions for open burning were zeroed out for air quality modeling and emissions for residential wood combustion were reduced for air quality modeling runs made with a burn ban in effect for Ada County.

8.3 DATA MANAGEMENT AND QUALITY ASSURANCE/QUALITY CONTROL

Future year area source emissions were calculated using Excel spreadsheets. A separate spreadsheet was developed for each area source category. A summary spreadsheet was then developed which linked to each of the individual source category spreadsheets. These spreadsheets are similar to those developed for the base year (see Section 3.4).

In general, procedures described in *Final Inventory Preparation Plan/Quality Assurance Plan (IPP/QAP)* (ENVIRON, 2001) were used to check, and correct when necessary, the area source emissions estimates. In particular, all area source emission calculations were internally checked by ERG staff. In addition, area source emission estimates were also reviewed by IDEQ staff and other inventory stakeholders.

Table 8-3a. Future year area sources annual emissions for Ada County (tons/year): 2010, 2015, 2020.

	2010						2015						2020					
Source Category	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**	**PM10**	**NOx**	**SOx**	**VOC**	**CO**	**NH3**
Residential Wood Combustion (Fireplaces and Firepits/Barb	264	20	3	1,748	1,929	0	298	22	3	1,974	2,178	0	306	23	4	2,023	2,231	0
Residential Wood Combustion (Woodstoves)	173	20	3	217	1,224	0	195	22	3	246	1,383	0	200	23	3	251	1,416	0
Other Fuel Combustion (Industrial Natural Gas)	9	328	1	6	98	4	10	364	1	7	109	4	11	408	1	8	123	5
Other Fuel Combustion (Comm/Inst Natural Gas)	16	208	1	11	174	1	17	229	1	13	192	1	19	247	1	14	207	1
Other Fuel Combustion (Residential Natural Gas)	31	382	2	22	163	2	35	432	3	25	184	2	36	442	3	26	188	2
Other Fuel Combustion (Industrial Propane)	0	11	0	0	2	0	0	12	0	0	2	0	0	13	0	0	2	0
Other Fuel Combustion (Comm/Inst Propane)	0	14	0	0	2	0	0	15	0	0	2	0	0	16	0	0	2	0
Other Fuel Combustion (Residential Propane)	0	15	0	0	2	0	0	17	0	0	2	0	1	18	0	0	2	0
Other Fuel Combustion (Industrial Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	0	3	5	0	1	0	0	3	5	0	1	0	0	3	5	0	1	0
Other Fuel Combustion (Industrial Residual)	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0
Other Fuel Combustion (Residential Residual)	3	7	11	0	2	0	3	8	13	0	2	0	3	8	13	0	2	0
Other Fuel Combustion (Residential Coal)	1	1	3	1	38	0	1	1	3	2	43	0	1	1	3	2	44	0
Open Burning (Residential MSW)	1,004	158	26	792	2,245	0	1,166	184	31	920	2,607	0	1,201	190	32	948	2,686	0
Open Burning (Residential Yard Waste)	173	0	0	128	511	0	201	0	0	148	593	0	207	0	0	153	611	0
Open Burning (Agricultural Fields)	61	0	0	47	432	0	61	0	0	46	429	0	60	0	0	46	426	0
Open Burning (Ditches)	2	0	0	1	11	0	2	0	0	1	11	0	2	0	0	1	11	0
Open Burning (Prescribed)	20	0	0	6	138	0	20	0	0	6	138	0	20	0	0	6	138	0
Other Fires (Structural)	2	0	0	2	11	0	2	0	0	2	12	0	2	0	0	2	12	0
Other Fires (Vehicles)	3	0	0	1	4	0	3	0	0	1	4	0	4	0	0	1	5	0
Other Fires (Wildfires)	183	43	0	258	1,504	0	183	43	0	258	1,504	0	183	43	0	258	1,504	0
Agricultural Windblown Dust	1,702	0	0	0	0	0	1,690	0	0	0	0	0	1,678	0	0	0	0	0
Fugitive Dust (Tillage)	1,145	0	0	0	0	0	1,138	0	0	0	0	0	1,130	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	261	0	0	0	0	0	261	0	0	0	0	0	261	0	0	0	0	0
Fugitive Dust (Construction Activities)	1,673	0	0	0	0	0	1,891	0	0	0	0	0	1,938	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	11	0	0	0	0	0	11	0	0	0	0	0	11	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	1,660	0	0	0	0	0	1,660	0	0	0	0	0	1,660
Fertilizer Ammonia	0	0	0	0	0	239	0	0	0	0	0	237	0	0	0	0	0	235
Cold Storage Ammonia	0	0	0	0	0	276	0	0	0	0	0	276	0	0	0	0	0	276
Biogenic Emissions	0	394	0	4,802	0	0	0	394	0	4,802	0	0	0	394	0	4,802	0	0
Gasoline Distribution (Stage I)	0	0	0	1,125	0	0	0	0	0	1,306	0	0	0	0	0	1,500	0	0

Gasoline Distribution (Stage II)	0	0	0	137	0	0	0	0	0	92	0	0	0	0	0	80	0	0
Gasoline Distribution (Underground Tank)	0	0	0	98	0	0	0	0	0	114	0	0	0	0	0	130	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	7	0	0	0	0	0	9	0	0	0	0	0	10	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Autobody Refinishing	0	0	0	75	0	0	0	0	0	83	0	0	0	0	0	93	0	0
Architectural Surface Coating	0	0	0	564	0	0	0	0	0	638	0	0	0	0	0	654	0	0
Dry Cleaning	0	0	0	415	0	0	0	0	0	470	0	0	0	0	0	481	0	0
Consumer Solvent Use	0	0	0	1,262	0	0	0	0	0	1,427	0	0	0	0	0	1,463	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	632	0	0	0	0	0	702	0	0	0	0	0	788	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	225	0	0	0	0	0	250	0	0	0	0	0	281	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electron	0	0	0	27	0	0	0	0	0	31	0	0	0	0	0	34	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	54	0	0	0	0	0	60	0	0	0	0	0	68	0	0
Graphic Arts	0	0	0	262	0	0	0	0	0	296	0	0	0	0	0	303	0	0
Surface Coating (Factory Finished Wood)	0	0	0	159	0	0	0	0	0	176	0	0	0	0	0	198	0	0
Surface Coating (Wood Furniture)	0	0	0	226	0	0	0	0	0	251	0	0	0	0	0	282	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	110	0	0	0	0	0	122	0	0	0	0	0	137	0	0
Surface Coating (Machinery and Equipment)	0	0	0	161	0	0	0	0	0	178	0	0	0	0	0	200	0	0
Surface Coating (Motor Vehicles)	0	0	0	359	0	0	0	0	0	399	0	0	0	0	0	448	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	9	0	0	0	0	0	10	0	0	0	0	0	11	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	112	0	0	0	0	0	124	0	0	0	0	0	139	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	149	0	0	0	0	0	165	0	0	0	0	0	185	0	0
Pesticides	0	0	0	138	0	0	0	0	0	137	0	0	0	0	0	136	0	0
Traffic Markings	0	0	0	88	0	0	0	0	0	99	0	0	0	0	0	101	0	0
Asphalt Paving	0	0	0	179	0	0	0	0	0	202	0	0	0	0	0	207	0	0
Charbroiling	84	0	0	0	0	0	95	0	0	0	0	0	97	0	0	0	0	0
Total	**6,821**	**1,605**	**57**	**14,618**	**8,490**	**2,181**	**7,285**	**1,748**	**65**	**15,794**	**9,396**	**2,180**	**7,372**	**1,832**	**67**	**16,473**	**9,613**	**2,179**

Table 8-3b. Future year area sources annual emissions for Canyon County (tons/year): 2010, 2015, 2020.

	2010						2015						2020					
Source Category	PM10	NOx	SOx	VOC	CO	NH3	PM10	NOx	SOx	VOC	CO	NH3	PM10	NOx	SOx	VOC	CO	NH3
Residential Wood Combustion (Fireplaces and Firepits/Barb	86	6	1	570	628	0	93	7	1	618	682	0	99	7	1	658	726	0
Residential Wood Combustion (Woodstoves)	120	13	2	175	905	0	130	14	2	190	983	0	139	15	2	202	1,046	0
Other Fuel Combustion (Industrial Natural Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Natural Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Natural Gas)	7	81	1	5	34	0	7	88	1	5	37	0	8	93	1	5	40	0
Other Fuel Combustion (Industrial Propane)	0	5	0	0	1	0	0	6	0	0	1	0	0	6	0	0	1	0
Other Fuel Combustion (Comm/Inst Propane)	0	5	0	0	1	0	0	6	0	0	1	0	0	6	0	0	1	0
Other Fuel Combustion (Residential Propane)	0	15	0	0	2	0	0	16	0	0	2	0	0	17	0	0	2	0
Other Fuel Combustion (Industrial Distillate)	2	15	22	0	3	1	2	16	23	0	3	1	2	17	24	0	4	1
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0
Other Fuel Combustion (Industrial Residual)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Residual)	5	11	19	0	3	0	5	12	20	0	3	0	6	13	21	0	3	1
Other Fuel Combustion (Residential Coal)	2	3	5	3	81	0	2	3	6	3	88	0	2	3	6	3	93	0
Open Burning (Residential MSW)	674	106	18	532	1,508	0	730	115	19	577	1,634	0	776	123	20	613	1,737	0
Open Burning (Residential Yard Waste)	116	0	0	86	343	0	126	0	0	93	372	0	134	0	0	99	395	0
Open Burning (Agricultural Fields)	248	0	0	203	1,585	0	245	0	0	200	1,560	0	241	0	0	197	1,536	0
Open Burning (Ditches)	5	0	0	3	26	0	4	0	0	3	25	0	4	0	0	3	25	0
Open Burning (Prescribed)	1	0	0	0	6	0	1	0	0	0	6	0	1	0	0	0	6	0
Other Fires (Structural)	1	0	0	1	6	0	1	0	0	1	6	0	1	0	0	1	7	0
Other Fires (Vehicles)	2	0	0	1	2	0	2	0	0	1	2	0	2	0	0	1	3	0
Other Fires (Wildfires)	10	2	0	13	78	0	10	2	0	13	78	0	10	2	0	13	78	0
Agricultural Windblown Dust	8,544	0	0	0	0	0	8,410	0	0	0	0	0	8,277	0	0	0	0	0
Fugitive Dust (Tillage)	3,927	0	0	0	0	0	3,866	0	0	0	0	0	3,804	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	1,340	0	0	0	0	0	1,340	0	0	0	0	0	1,340	0	0	0	0	0
Fugitive Dust (Construction Activities)	635	0	0	0	0	0	688	0	0	0	0	0	731	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	2,731	0	0	0	0	0	2,731	0	0	0	0	0	2,731
Fertilizer Ammonia	0	0	0	0	0	714	0	0	0	0	0	703	0	0	0	0	0	691
Cold Storage Ammonia	0	0	0	0	0	609	0	0	0	0	0	609	0	0	0	0	0	609
Biogenic Emissions	0	167	0	6,288	0	0	0	167	0	6,288	0	0	0	167	0	6,288	0	0
Gasoline Distribution (Stage I)	0	0	0	505	0	0	0	0	0	573	0	0	0	0	0	654	0	0

Gasoline Distribution (Stage II)	0	0	0	61	0	0	0	0	0	40	0	0	0	0	0	35	0	0
Gasoline Distribution (Underground Tank)	0	0	0	44	0	0	0	0	0	50	0	0	0	0	0	57	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	3	0	0	0	0	0	4	0	0	0	0	0	4	0	0
Aviation Refueling	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Autobody Refinishing	0	0	0	24	0	0	0	0	0	26	0	0	0	0	0	27	0	0
Architectural Surface Coating	0	0	0	235	0	0	0	0	0	254	0	0	0	0	0	270	0	0
Dry Cleaning	0	0	0	73	0	0	0	0	0	79	0	0	0	0	0	84	0	0
Consumer Solvent Use	0	0	0	525	0	0	0	0	0	569	0	0	0	0	0	604	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	203	0	0	0	0	0	213	0	0	0	0	0	224	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	25	0	0	0	0	0	26	0	0	0	0	0	27	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electron	0	0	0	36	0	0	0	0	0	38	0	0	0	0	0	40	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	41	0	0	0	0	0	43	0	0	0	0	0	45	0	0
Graphic Arts	0	0	0	109	0	0	0	0	0	118	0	0	0	0	0	125	0	0
Surface Coating (Factory Finished Wood)	0	0	0	15	0	0	0	0	0	16	0	0	0	0	0	17	0	0
Surface Coating (Wood Furniture)	0	0	0	63	0	0	0	0	0	66	0	0	0	0	0	70	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	16	0	0	0	0	0	17	0	0	0	0	0	18	0	0
Surface Coating (Machinery and Equipment)	0	0	0	88	0	0	0	0	0	93	0	0	0	0	0	97	0	0
Surface Coating (Motor Vehicles)	0	0	0	182	0	0	0	0	0	192	0	0	0	0	0	201	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	42	0	0	0	0	0	44	0	0	0	0	0	46	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	55	0	0	0	0	0	58	0	0	0	0	0	61	0	0
Pesticides	0	0	0	565	0	0	0	0	0	557	0	0	0	0	0	548	0	0
Traffic Markings	0	0	0	36	0	0	0	0	0	39	0	0	0	0	0	42	0	0
Asphalt Paving	0	0	0	181	0	0	0	0	0	196	0	0	0	0	0	208	0	0
Charbroiling	35	0	0	0	0	0	38	0	0	0	0	0	40	0	0	0	0	0
Total	**15,761**	**431**	**69**	**11,011**	**5,214**	**4,055**	**15,703**	**452**	**74**	**11,306**	**5,485**	**4,044**	**15,620**	**471**	**78**	**11,592**	**5,703**	**4,033**

Table 8-4a. Year 2010 area sources episode emissions for Ada County by day type (lbs/day).

Ada 2010 Area Source Category	1-Digit Weekday PM10	2-Digit Weekday PM10	Weekend Day PM10	1-Digit Weekday NOx	2-Digit Weekday NOx	Weekend Day NOx	1-Digit Weekday SOx	2-Digit Weekday SOx	Weekend Day SOx	1-Digit Weekday VOC	2-Digit Weekday VOC	Weekend Day VOC	1-Digit Weekday CO	2-Digit Weekday CO	Weekend Day CO	1-Digit Weekday NH3	2-Digit Weekday NH3	Weekend Day NH3
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	2,424	2,424	9,889	182	182	743	28	28	114	16,045	16,045	65,447	17,699	17,699	72,192	0	0	0
Residential Wood Combustion (Woodstoves)	2,715	2,715	6,276	311	311	719	46	46	107	3,414	3,414	7,893	19,229	19,229	44,451	0	0	0
Other Fuel Combustion (Industrial Natural Gas)	65	65	65	2,411	2,411	2,411	5	5	5	47	47	47	723	723	723	28	28	28
Other Fuel Combustion (Comm/Inst Natural Gas)	130	130	130	1,712	1,712	1,712	10	10	10	94	94	94	1,438	1,438	1,438	8	8	8
Other Fuel Combustion (Residential Natural Gas)	276	276	276	3,414	3,414	3,414	22	22	22	200	200	200	1,453	1,453	1,453	18	18	18
Other Fuel Combustion (Industrial Propane)	3	3	3	89	89	89	0	0	0	1	1	1	15	15	15	0	0	0
Other Fuel Combustion (Comm/Inst Propane)	3	3	3	106	106	106	0	0	0	2	2	2	14	14	14	0	0	0
Other Fuel Combustion (Residential Propane)	4	4	4	132	132	132	0	0	0	3	3	3	18	18	18	0	0	0
Other Fuel Combustion (Industrial Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	3	3	3	34	34	34	59	59	59	1	1	1	9	9	9	2	2	2
Other Fuel Combustion (Industrial Residual)	1	1	1	4	4	4	3	3	3	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	3	3	3	8	8	8	13	13	13	0	0	0	2	2	2	0	0	0
Other Fuel Combustion (Residential Residual)	36	36	36	86	86	86	141	141	141	3	3	3	21	21	21	3	3	3
Other Fuel Combustion (Residential Coal)	10	10	10	15	15	15	31	31	31	17	17	17	462	462	462	0	0	0
Open Burning (Residential MSW)	5,500	5,500	5,500	868	868	868	145	145	145	4,342	4,342	4,342	12,303	12,303	12,303	0	0	0
Open Burning (Residential Yard Waste)	950	950	950	0	0	0	0	0	0	700	700	700	2,800	2,800	2,800	0	0	0
Open Burning (Agricultural Fields)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Ditches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Prescribed)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fires (Structural)	11	11	11	1	1	1	0	0	0	11	11	11	59	59	59	0	0	0
Other Fires (Vehicles)	16	16	16	1	1	1	0	0	0	5	5	5	20	20	20	0	0	0
Other Fires (Wildfires)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Windblown Dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Tillage)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	714	0	714	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Construction Activities)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9,093	9,093	9,093
Fertilizer Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,510	1,510	1,510
Biogenic Emissions	0	0	0	941	941	941	0	0	0	2,374	2,374	2,374	0	0	0	0	0	0
Gasoline Distribution (Stage I)	0	0	0	0	0	0	0	0	0	6,165	6,165	6,165	0	0	0	0	0	0
Gasoline Distribution (Stage II)	0	0	0	0	0	0	0	0	0	911	911	911	0	0	0	0	0	0
Gasoline Distribution (Underground Tank)	0	0	0	0	0	0	0	0	0	536	536	536	0	0	0	0	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	0	0	0	0	0	0	40	40	40	0	0	0	0	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Autobody Refinishing	0	0	0	0	0	0	0	0	0	410	410	0	0	0	0	0	0	0
Architectural Surface Coating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0	0	0	2,276	2,276	0	0	0	0	0	0	0
Consumer Solvent Use	0	0	0	0	0	0	0	0	0	6,916	6,916	6,916	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	0	0	0	0	0	0	3,462	3,462	0	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	0	0	0	0	0	0	1,235	1,235	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and	0	0	0	0	0	0	0	0	0	151	151	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	0	0	0	0	0	0	298	298	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0	0	0	1,434	1,434	0	0	0	0	0	0	0
Surface Coating (Factory Finished Wood)	0	0	0	0	0	0	0	0	0	869	869	0	0	0	0	0	0	0
Surface Coating (Wood Furniture)	0	0	0	0	0	0	0	0	0	1,238	1,238	0	0	0	0	0	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	0	0	0	0	0	0	600	600	0	0	0	0	0	0	0
Surface Coating (Machinery and Equipment)	0	0	0	0	0	0	0	0	0	880	880	0	0	0	0	0	0	0
Surface Coating (Motor Vehicles)	0	0	0	0	0	0	0	0	0	1,969	1,969	0	0	0	0	0	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	0	0	0	0	0	0	47	47	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	0	0	0	0	0	0	611	611	0	0	0	0	0	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	0	0	0	0	0	0	815	815	0	0	0	0	0	0	0
Pesticides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Traffic Markings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asphalt Paving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charbroiling	459	459	459	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**13,325**	**12,611**	**24,350**	**10,317**	**10,317**	**11,286**	**504**	**504**	**650**	**58,126**	**58,126**	**95,711**	**56,267**	**56,267**	**135,983**	**10,662**	**10,662**	**10,662**

Note: These numbers represent the estimated area source emissions following the procedures described in this chapter. Emissions for open burning were zeroed out for air quality modeling, and emissions for residential wood combustion were reduced for air quality modeling runs made with a burn ban in effect for Ada County.

Table 8-4b. Year 2015 area sources episode emissions for Ada County by day type (lbs/day).

Ada 2015 Area Source Category	1-Digit Weekday PM10	2-Digit Weekday PM10	Weekend Day PM10	1-Digit Weekday NOx	2-Digit Weekday NOx	Weekend Day NOx	1-Digit Weekday SOx	2-Digit Weekday SOx	Weekend Day SOx	1-Digit Weekday VOC	2-Digit Weekday VOC	Weekend Day VOC	1-Digit Weekday CO	2-Digit Weekday CO	Weekend Day CO	1-Digit Weekday NH3	2-Digit Weekday NH3	Weekend Day NH3
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	2,738	2,738	11,167	206	206	839	32	32	129	18,119	18,119	73,907	19,986	19,986	81,524	0	0	0
Residential Wood Combustion (Woodstoves)	3,066	3,066	7,087	351	351	812	52	52	121	3,856	3,856	8,913	21,715	21,715	50,197	0	0	0
Other Fuel Combustion (Industrial Natural Gas)	73	73	73	2,677	2,677	2,677	6	6	6	53	53	53	803	803	803	31	31	31
Other Fuel Combustion (Comm/Inst Natural Gas)	143	143	143	1,885	1,885	1,885	11	11	11	104	104	104	1,584	1,584	1,584	9	9	9
Other Fuel Combustion (Residential Natural Gas)	312	312	312	3,856	3,856	3,856	25	25	25	226	226	226	1,641	1,641	1,641	20	20	20
Other Fuel Combustion (Industrial Propane)	3	3	3	99	99	99	0	0	0	2	2	2	17	17	17	0	0	0
Other Fuel Combustion (Comm/Inst Propane)	3	3	3	117	117	117	0	0	0	3	3	3	16	16	16	0	0	0
Other Fuel Combustion (Residential Propane)	4	4	4	149	149	149	0	0	0	3	3	3	20	20	20	0	0	0
Other Fuel Combustion (Industrial Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	4	4	4	38	38	38	66	66	66	2	2	2	11	11	11	2	2	2
Other Fuel Combustion (Industrial Residual)	1	1	1	4	4	4	3	3	3	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	4	4	4	9	9	9	15	15	15	0	0	0	2	2	2	0	0	0
Other Fuel Combustion (Residential Residual)	41	41	41	97	97	97	159	159	159	3	3	3	24	24	24	4	4	4
Other Fuel Combustion (Residential Coal)	12	12	12	17	17	17	35	35	35	19	19	19	521	521	521	0	0	0
Open Burning (Residential MSW)	6,386	6,386	6,386	1,008	1,008	1,008	168	168	168	5,042	5,042	5,042	14,286	14,286	14,286	0	0	0
Open Burning (Residential Yard Waste)	1,103	1,103	1,103	0	0	0	0	0	0	813	813	813	3,251	3,251	3,251	0	0	0
Open Burning (Agricultural Fields)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Ditches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Prescribed)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fires (Structural)	12	12	12	2	2	2	0	0	0	12	12	12	66	66	66	0	0	0
Other Fires (Vehicles)	19	19	19	1	1	1	0	0	0	6	6	6	24	24	24	0	0	0
Other Fires (Wildfires)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Windblown Dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Tillage)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	714	0	714	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Construction Activities)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9,093	9,093	9,093
Fertilizer Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,510	1,510	1,510
Biogenic Emissions	0	0	0	941	941	941	0	0	0	2,374	2,374	2,374	0	0	0	0	0	0
Gasoline Distribution (Stage I)	0	0	0	0	0	0	0	0	0	7,157	7,157	7,157	0	0	0	0	0	0
Gasoline Distribution (Stage II)	0	0	0	0	0	0	0	0	0	597	597	597	0	0	0	0	0	0
Gasoline Distribution (Underground Tank)	0	0	0	0	0	0	0	0	0	622	622	622	0	0	0	0	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	0	0	0	0	0	0	47	47	47	0	0	0	0	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Autobody Refinishing	0	0	0	0	0	0	0	0	0	455	455	0	0	0	0	0	0	0
Architectural Surface Coating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0	0	0	2,574	2,574	0	0	0	0	0	0	0
Consumer Solvent Use	0	0	0	0	0	0	0	0	0	7,821	7,821	7,821	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	0	0	0	0	0	0	3,845	3,845	0	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	0	0	0	0	0	0	1,372	1,372	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and	0	0	0	0	0	0	0	0	0	167	167	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	0	0	0	0	0	0	331	331	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0	0	0	1,621	1,621	0	0	0	0	0	0	0
Surface Coating (Factory Finished Wood)	0	0	0	0	0	0	0	0	0	966	966	0	0	0	0	0	0	0
Surface Coating (Wood Furniture)	0	0	0	0	0	0	0	0	0	1,376	1,376	0	0	0	0	0	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	0	0	0	0	0	0	667	667	0	0	0	0	0	0	0
Surface Coating (Machinery and Equipment)	0	0	0	0	0	0	0	0	0	978	978	0	0	0	0	0	0	0
Surface Coating (Motor Vehicles)	0	0	0	0	0	0	0	0	0	2,187	2,187	0	0	0	0	0	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	0	0	0	0	0	0	52	52	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	0	0	0	0	0	0	679	679	0	0	0	0	0	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	0	0	0	0	0	0	905	905	0	0	0	0	0	0	0
Pesticides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Traffic Markings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asphalt Paving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charbroiling	519	519	519	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**15,157**	**14,443**	**27,607**	**11,458**	**11,458**	**12,552**	**572**	**572**	**738**	**65,054**	**65,054**	**107,725**	**63,968**	**63,968**	**153,987**	**10,669**	**10,669**	**10,669**

Note: These numbers represent the estimated area source emissions following the procedures described in this chapter. Emissions for open burning were zeroed out for air quality modeling, and emissions for residential wood combustion were reduced for air quality modeling runs made with a burn ban in effect for Ada County.

Table 8-4c. Year 2020 area sources episode emissions for Ada County by day type (lbs/day).

Ada 2020 Area Source Category	1-Digit Weekday PM10	2-Digit Weekday PM10	Weekend Day PM10	1-Digit Weekday NOx	2-Digit Weekday NOx	Weekend Day NOx	1-Digit Weekday SOx	2-Digit Weekday SOx	Weekend Day SOx	1-Digit Weekday VOC	2-Digit Weekday VOC	Weekend Day VOC	1-Digit Weekday CO	2-Digit Weekday CO	Weekend Day CO	1-Digit Weekday NH3	2-Digit Weekday NH3	Weekend Day NH3
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	2,804	2,804	11,439	211	211	860	32	32	132	18,561	18,561	75,710	20,474	20,474	83,512	0	0	0
Residential Wood Combustion (Woodstoves)	3,141	3,141	7,260	360	360	832	54	54	124	3,950	3,950	9,131	22,244	22,244	51,422	0	0	0
Other Fuel Combustion (Industrial Natural Gas)	82	82	82	3,006	3,006	3,006	6	6	6	59	59	59	902	902	902	34	34	34
Other Fuel Combustion (Comm/Inst Natural Gas)	155	155	155	2,035	2,035	2,035	12	12	12	112	112	112	1,710	1,710	1,710	10	10	10
Other Fuel Combustion (Residential Natural Gas)	319	319	319	3,950	3,950	3,950	25	25	25	231	231	231	1,681	1,681	1,681	21	21	21
Other Fuel Combustion (Industrial Propane)	4	4	4	112	112	112	0	0	0	2	2	2	19	19	19	0	0	0
Other Fuel Combustion (Comm/Inst Propane)	4	4	4	126	126	126	0	0	0	3	3	3	17	17	17	0	0	0
Other Fuel Combustion (Residential Propane)	4	4	4	153	153	153	0	0	0	3	3	3	21	21	21	0	0	0
Other Fuel Combustion (Industrial Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	4	4	4	39	39	39	68	68	68	2	2	2	11	11	11	2	2	2
Other Fuel Combustion (Industrial Residual)	1	1	1	5	5	5	3	3	3	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	4	4	4	10	10	10	16	16	16	0	0	0	2	2	2	0	0	0
Other Fuel Combustion (Residential Residual)	42	42	42	99	99	99	163	163	163	4	4	4	25	25	25	4	4	4
Other Fuel Combustion (Residential Coal)	12	12	12	18	18	18	36	36	36	19	19	19	534	534	534	0	0	0
Open Burning (Residential MSW)	6,581	6,581	6,581	1,039	1,039	1,039	173	173	173	5,195	5,195	5,195	14,720	14,720	14,720	0	0	0
Open Burning (Residential Yard Waste)	1,137	1,137	1,137	0	0	0	0	0	0	838	838	838	3,350	3,350	3,350	0	0	0
Open Burning (Agricultural Fields)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Ditches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Prescribed)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fires (Structural)	12	12	12	2	2	2	0	0	0	12	12	12	68	68	68	0	0	0
Other Fires (Vehicles)	22	22	22	1	1	1	0	0	0	7	7	7	27	27	27	0	0	0
Other Fires (Wildfires)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Windblown Dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Tillage)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	714	0	714	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Construction Activities)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9,093	9,093	9,093
Fertilizer Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,510	1,510	1,510
Biogenic Emissions	0	0	0	941	941	941	0	0	0	2,374	2,374	2,374	0	0	0	0	0	0
Gasoline Distribution (Stage I)	0	0	0	0	0	0	0	0	0	8,221	8,221	8,221	0	0	0	0	0	0
Gasoline Distribution (Stage II)	0	0	0	0	0	0	0	0	0	515	515	515	0	0	0	0	0	0
Gasoline Distribution (Underground Tank)	0	0	0	0	0	0	0	0	0	715	715	715	0	0	0	0	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	0	0	0	0	0	0	54	54	54	0	0	0	0	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Autobody Refinishing	0	0	0	0	0	0	0	0	0	511	511	0	0	0	0	0	0	0
Architectural Surface Coating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0	0	0	2,638	2,638	0	0	0	0	0	0	0
Consumer Solvent Use	0	0	0	0	0	0	0	0	0	8,014	8,014	8,014	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	0	0	0	0	0	0	4,316	4,316	0	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	0	0	0	0	0	0	1,540	1,540	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and E	0	0	0	0	0	0	0	0	0	188	188	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	0	0	0	0	0	0	372	372	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0	0	0	1,661	1,661	0	0	0	0	0	0	0
Surface Coating (Factory Finished Wood)	0	0	0	0	0	0	0	0	0	1,084	1,084	0	0	0	0	0	0	0
Surface Coating (Wood Furniture)	0	0	0	0	0	0	0	0	0	1,544	1,544	0	0	0	0	0	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	0	0	0	0	0	0	748	748	0	0	0	0	0	0	0
Surface Coating (Machinery and Equipment)	0	0	0	0	0	0	0	0	0	1,097	1,097	0	0	0	0	0	0	0
Surface Coating (Motor Vehicles)	0	0	0	0	0	0	0	0	0	2,455	2,455	0	0	0	0	0	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	0	0	0	0	0	0	59	59	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	0	0	0	0	0	0	762	762	0	0	0	0	0	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	0	0	0	0	0	0	1,016	1,016	0	0	0	0	0	0	0
Pesticides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Traffic Markings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asphalt Paving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charbroiling	532	532	532	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**15,573**	**14,859**	**28,327**	**12,105**	**12,105**	**13,226**	**590**	**590**	**760**	**68,883**	**68,883**	**111,220**	**65,806**	**65,806**	**158,021**	**10,674**	**10,674**	**10,674**

Note: These numbers represent the estimated area source emissions following the procedures described in this chapter. Emissions for open burning were zeroed out for air quality modeling, and emissions for residential wood combustion were reduced for air quality modeling runs made with a burn ban in effect for Ada County.

Table 8-4d. Year 2010 area sources episode emissions for Canyon County by day type (lbs/day).

Canyon 2010 Area Source Category	1-Digit Weekday PM10	2-Digit Weekday PM10	Weekend Day PM10	1-Digit Weekday NOx	2-Digit Weekday NOx	Weekend Day NOx	1-Digit Weekday SOx	2-Digit Weekday SOx	Weekend Day SOx	1-Digit Weekday VOC	2-Digit Weekday VOC	Weekend Day VOC	1-Digit Weekday CO	2-Digit Weekday CO	Weekend Day CO	1-Digit Weekday NH3	2-Digit Weekday NH3	Weekend Day NH3
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	744	744	3,035	56	56	228	9	9	35	4,925	4,925	20,090	5,433	5,433	22,160	0	0	0
Residential Wood Combustion (Woodstoves)	1,664	1,664	3,847	181	181	419	25	25	59	2,421	2,421	5,597	12,530	12,530	28,965	0	0	0
Other Fuel Combustion (Industrial Natural Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Natural Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Natural Gas)	67	67	67	828	828	828	5	5	5	48	48	48	352	352	352	4	4	4
Other Fuel Combustion (Industrial Propane)	2	2	2	49	49	49	0	0	0	1	1	1	8	8	8	0	0	0
Other Fuel Combustion (Comm/Inst Propane)	1	1	1	47	47	47	0	0	0	1	1	1	6	6	6	0	0	0
Other Fuel Combustion (Residential Propane)	4	4	4	131	131	131	0	0	0	3	3	3	18	18	18	0	0	0
Other Fuel Combustion (Industrial Distillate)	11	11	11	80	80	80	115	115	115	1	1	1	17	17	17	3	3	3
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	1	1	1	10	10	10	18	18	18	0	0	0	3	3	3	0	0	0
Other Fuel Combustion (Industrial Residual)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	1	1	1	3	3	3	4	4	4	0	0	0	1	1	1	0	0	0
Other Fuel Combustion (Residential Residual)	60	60	60	142	142	142	234	234	234	5	5	5	35	35	35	6	6	6
Other Fuel Combustion (Residential Coal)	27	27	27	40	40	40	82	82	82	44	44	44	1,210	1,210	1,210	0	0	0
Open Burning (Residential MSW)	3,695	3,695	3,695	583	583	583	97	97	97	2,917	2,917	2,917	8,265	8,265	8,265	0	0	0
Open Burning (Residential Yard Waste)	638	638	638	0	0	0	0	0	0	470	470	470	1,881	1,881	1,881	0	0	0
Open Burning (Agricultural Fields)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Ditches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Prescribed)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fires (Structural)	6	6	6	1	1	1	0	0	0	6	6	6	32	32	32	0	0	0
Other Fires (Vehicles)	9	9	9	0	0	0	0	0	0	3	3	3	11	11	11	0	0	0
Other Fires (Wildfires)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Windblown Dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Tillage)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	3,670	0	3,670	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Construction Activities)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,967	14,967	14,967
Fertilizer Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,335	3,335	3,335
Biogenic Emissions	0	0	0	408	408	408	0	0	0	3,375	3,375	3,375	0	0	0	0	0	0
Gasoline Distribution (Stage I)	0	0	0	0	0	0	0	0	0	2,766	2,766	2,766	0	0	0	0	0	0
Gasoline Distribution (Stage II)	0	0	0	0	0	0	0	0	0	409	409	409	0	0	0	0	0	0
Gasoline Distribution (Underground Tank)	0	0	0	0	0	0	0	0	0	240	240	240	0	0	0	0	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	0	0	0	0	0	0	18	18	18	0	0	0	0	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	3	3	3	0	0	0	0	0	0
Autobody Refinishing	0	0	0	0	0	0	0	0	0	134	134	0	0	0	0	0	0	0
Architectural Surface Coating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0	0	0	398	398	0	0	0	0	0	0	0
Consumer Solvent Use	0	0	0	0	0	0	0	0	0	2,877	2,877	2,877	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	0	0	0	0	0	0	1,111	1,111	0	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	0	0	0	0	0	0	136	136	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and Electrical)	0	0	0	0	0	0	0	0	0	199	199	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	0	0	0	0	0	0	223	223	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0	0	0	596	596	0	0	0	0	0	0	0
Surface Coating (Factory Finished Wood)	0	0	0	0	0	0	0	0	0	84	84	0	0	0	0	0	0	0
Surface Coating (Wood Furniture)	0	0	0	0	0	0	0	0	0	346	346	0	0	0	0	0	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	0	0	0	0	0	0	88	88	0	0	0	0	0	0	0
Surface Coating (Machinery and Equipment)	0	0	0	0	0	0	0	0	0	482	482	0	0	0	0	0	0	0
Surface Coating (Motor Vehicles)	0	0	0	0	0	0	0	0	0	999	999	0	0	0	0	0	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	8	8	0	0	0	0	0	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	0	0	0	0	0	0	228	228	0	0	0	0	0	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	0	0	0	0	0	0	304	304	0	0	0	0	0	0	0
Pesticides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Traffic Markings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asphalt Paving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charbroiling	191	191	191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**10,792**	**7,122**	**15,266**	**2,559**	**2,559**	**2,969**	**589**	**589**	**649**	**25,871**	**25,871**	**38,875**	**29,803**	**29,803**	**62,965**	**18,315**	**18,315**	**18,315**

Note: These numbers represent the estimated area source emissions following the procedures described in this chapter. Emissions for open burning were zeroed out for air quality modeling, and emissions for residential wood combustion were reduced for air quality modeling runs made with a burn ban in effect for Ada County.

Table 8-4e. Year 2015 area sources episode emissions for Canyon County by day type (lbs/day).

Canyon 2015	Digit Week	Digit Week	Weekend Da	Digit Week	Digit Week	Weekend Da	Digit Week	Digit Week	Weekend Da	Digit Week	Digit Week	Weekend Da	Digit Week	Digit Week	Weekend Da	Digit Week	Digit Week	Weekend Da
Area Source Category	**PM10**	**PM10**	**PM10**	**NOx**	**NOx**	**NOx**	**SOx**	**SOx**	**SOx**	**VOC**	**VOC**	**VOC**	**CO**	**CO**	**CO**	**NH3**	**NH3**	**NH3**
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	808	808	3,295	61	61	248	9	9	38	5,346	5,346	21,807	5,897	5,897	24,054	0	0	0
Residential Wood Combustion (Woodstoves)	1,806	1,806	4,175	197	197	455	28	28	64	2,628	2,628	6,076	13,601	13,601	31,441	0	0	0
Other Fuel Combustion (Industrial Natural Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Natural Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Natural Gas)	73	73	73	898	898	898	6	6	6	53	53	53	382	382	382	5	5	5
Other Fuel Combustion (Industrial Propane)	2	2	2	51	51	51	0	0	0	1	1	1	9	9	9	0	0	0
Other Fuel Combustion (Comm/Inst Propane)	1	1	1	52	52	52	0	0	0	1	1	1	7	7	7	0	0	0
Other Fuel Combustion (Residential Propane)	4	4	4	143	143	143	0	0	0	3	3	3	19	19	19	0	0	0
Other Fuel Combustion (Industrial Distillate)	12	12	12	84	84	84	121	121	121	1	1	1	17	17	17	3	3	3
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	1	1	1	11	11	11	19	19	19	0	0	0	3	3	3	0	0	0
Other Fuel Combustion (Industrial Residual)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	1	1	1	3	3	3	5	5	5	0	0	0	1	1	1	0	0	0
Other Fuel Combustion (Residential Residual)	65	65	65	154	154	154	254	254	254	5	5	5	38	38	38	6	6	6
Other Fuel Combustion (Residential Coal)	30	30	30	43	43	43	89	89	89	48	48	48	1,313	1,313	1,313	0	0	0
Open Burning (Residential MSW)	4,002	4,002	4,002	632	632	632	105	105	105	3,159	3,159	3,159	8,951	8,951	8,951	0	0	0
Open Burning (Residential Yard Waste)	691	691	691	0	0	0	0	0	0	509	509	509	2,037	2,037	2,037	0	0	0
Open Burning (Agricultural Fields)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Ditches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Prescribed)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fires (Structural)	6	6	6	1	1	1	0	0	0	6	6	6	35	35	35	0	0	0
Other Fires (Vehicles)	10	10	10	0	0	0	0	0	0	3	3	3	13	13	13	0	0	0
Other Fires (Wildfires)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Windblown Dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Tillage)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	3,670	0	3,670	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Construction Activities)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,967	14,967	14,967
Fertilizer Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,335	3,335	3,335
Biogenic Emissions	0	0	0	408	408	408	0	0	0	3,375	3,375	3,375	0	0	0	0	0	0
Gasoline Distribution (Stage I)	0	0	0	0	0	0	0	0	0	3,140	3,140	3,140	0	0	0	0	0	0
Gasoline Distribution (Stage II)	0	0	0	0	0	0	0	0	0	262	262	262	0	0	0	0	0	0
Gasoline Distribution (Underground Tank)	0	0	0	0	0	0	0	0	0	273	273	273	0	0	0	0	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	0	0	0	0	0	0	20	20	20	0	0	0	0	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	3	3	3	0	0	0	0	0	0
Autobody Refinishing	0	0	0	0	0	0	0	0	0	141	141	0	0	0	0	0	0	0
Architectural Surface Coating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0	0	0	431	431	0	0	0	0	0	0	0
Consumer Solvent Use	0	0	0	0	0	0	0	0	0	3,116	3,116	3,116	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	0	0	0	0	0	0	1,169	1,169	0	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	0	0	0	0	0	0	143	143	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and Electrical)	0	0	0	0	0	0	0	0	0	209	209	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	0	0	0	0	0	0	235	235	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0	0	0	646	646	0	0	0	0	0	0	0
Surface Coating (Factory Finished Wood)	0	0	0	0	0	0	0	0	0	89	89	0	0	0	0	0	0	0
Surface Coating (Wood Furniture)	0	0	0	0	0	0	0	0	0	364	364	0	0	0	0	0	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	0	0	0	0	0	0	92	92	0	0	0	0	0	0	0
Surface Coating (Machinery and Equipment)	0	0	0	0	0	0	0	0	0	507	507	0	0	0	0	0	0	0
Surface Coating (Motor Vehicles)	0	0	0	0	0	0	0	0	0	1,050	1,050	0	0	0	0	0	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	8	8	0	0	0	0	0	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	0	0	0	0	0	0	240	240	0	0	0	0	0	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	0	0	0	0	0	0	320	320	0	0	0	0	0	0	0
Pesticides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Traffic Markings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asphalt Paving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charbroiling	207	207	207	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**11,390**	**7,719**	**16,246**	**2,738**	**2,738**	**3,183**	**635**	**635**	**700**	**27,599**	**27,599**	**41,863**	**32,324**	**32,324**	**68,321**	**18,316**	**18,316**	**18,316**

Note: These numbers represent the estimated area source emissions following the procedures described in this chapter. Emissions for open burning were zeroed out for air quality modeling, and emissions for residential wood combustion were reduced for air quality modeling runs made with a burn ban in effect for Ada County.

Table 8-4f. Year 2020 area sources episode emissions for Canyon County by day type (lbs/day).

Canyon 2020 Area Source Category	Digit Weekd PM10	Digit Weekd PM10	Weekend Da PM10	Digit Weekd NOx	Digit Weekd NOx	Weekend Da NOx	Digit Weekd SOx	Digit Weekd SOx	Weekend Da SOx	Digit Weekd VOC	Digit Weekd VOC	Weekend Da VOC	Digit Weekd CO	Digit Weekd CO	Weekend Da CO	Digit Weekd NH3	Digit Weekd NH3	Weekend Day NH3
Residential Wood Combustion (Fireplaces and Firepits/Barbecues)	860	860	3,507	65	65	264	10	10	41	5,690	5,690	23,210	6,277	6,277	25,602	0	0	0
Residential Wood Combustion (Woodstoves)	1,922	1,922	4,444	209	209	484	29	29	68	2,797	2,797	6,467	14,476	14,476	33,464	0	0	0
Other Fuel Combustion (Industrial Natural Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Natural Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Natural Gas)	77	77	77	956	956	956	6	6	6	56	56	56	407	407	407	5	5	5
Other Fuel Combustion (Industrial Propane)	2	2	2	54	54	54	0	0	0	1	1	1	9	9	9	0	0	0
Other Fuel Combustion (Comm/Inst Propane)	2	2	2	58	58	58	0	0	0	1	1	1	8	8	8	0	0	0
Other Fuel Combustion (Residential Propane)	4	4	4	152	152	152	0	0	0	3	3	3	21	21	21	0	0	0
Other Fuel Combustion (Industrial Distillate)	12	12	12	88	88	88	126	126	126	1	1	1	18	18	18	3	3	3
Other Fuel Combustion (Comm/Inst Distillate)	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Residential Distillate)	1	1	1	12	12	12	20	20	20	0	0	0	3	3	3	1	1	1
Other Fuel Combustion (Industrial Residual)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fuel Combustion (Comm/Inst Residual)	1	1	1	3	3	3	5	5	5	0	0	0	1	1	1	0	0	0
Other Fuel Combustion (Residential Residual)	70	70	70	164	164	164	270	270	270	6	6	6	41	41	41	7	7	7
Other Fuel Combustion (Residential Coal)	32	32	32	46	46	46	95	95	95	51	51	51	1,398	1,398	1,398	0	0	0
Open Burning (Residential MSW)	4,254	4,254	4,254	672	672	672	112	112	112	3,358	3,358	3,358	9,515	9,515	9,515	0	0	0
Open Burning (Residential Yard Waste)	735	735	735	0	0	0	0	0	0	541	541	541	2,166	2,166	2,166	0	0	0
Open Burning (Agricultural Fields)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Ditches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Burning (Prescribed)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fires (Structural)	7	7	7	1	1	1	0	0	0	7	7	7	37	37	37	0	0	0
Other Fires (Vehicles)	12	12	12	0	0	0	0	0	0	4	4	4	15	15	15	0	0	0
Other Fires (Wildfires)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Windblown Dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Tillage)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Harvest)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Feedlots)	3,670	0	3,670	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Construction Activities)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Dust (Natural Wind Erosion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,967	14,967	14,967
Fertilizer Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,335	3,335	3,335
Biogenic Emissions	0	0	0	408	408	408	0	0	0	3,375	3,375	3,375	0	0	0	0	0	0
Gasoline Distribution (Stage I)	0	0	0	0	0	0	0	0	0	3,584	3,584	3,584	0	0	0	0	0	0
Gasoline Distribution (Stage II)	0	0	0	0	0	0	0	0	0	224	224	224	0	0	0	0	0	0
Gasoline Distribution (Underground Tank)	0	0	0	0	0	0	0	0	0	312	312	312	0	0	0	0	0	0
Gasoline Distribution (Tank Truck Transit)	0	0	0	0	0	0	0	0	0	23	23	23	0	0	0	0	0	0
Aviation Refueling	0	0	0	0	0	0	0	0	0	4	4	4	0	0	0	0	0	0
Autobody Refinishing	0	0	0	0	0	0	0	0	0	147	147	0	0	0	0	0	0	0
Architectural Surface Coating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0	0	0	458	458	0	0	0	0	0	0	0
Consumer Solvent Use	0	0	0	0	0	0	0	0	0	3,312	3,312	3,312	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Automobile Repair)	0	0	0	0	0	0	0	0	0	1,226	1,226	0	0	0	0	0	0	0
Solvent Degreasing (Cold Cleaning - Manufacturing)	0	0	0	0	0	0	0	0	0	150	150	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and E	0	0	0	0	0	0	0	0	0	219	219	0	0	0	0	0	0	0
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	0	0	0	0	0	0	0	0	0	247	247	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0	0	0	686	686	0	0	0	0	0	0	0
Surface Coating (Factory Finished Wood)	0	0	0	0	0	0	0	0	0	93	93	0	0	0	0	0	0	0
Surface Coating (Wood Furniture)	0	0	0	0	0	0	0	0	0	382	382	0	0	0	0	0	0	0
Surface Coating (Misc. Finished Metals)	0	0	0	0	0	0	0	0	0	97	97	0	0	0	0	0	0	0
Surface Coating (Machinery and Equipment)	0	0	0	0	0	0	0	0	0	532	532	0	0	0	0	0	0	0
Surface Coating (Motor Vehicles)	0	0	0	0	0	0	0	0	0	1,102	1,102	0	0	0	0	0	0	0
Surface Coating (Marine)	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0
Surface Coating (Railroad)	0	0	0	0	0	0	0	0	0	8	8	0	0	0	0	0	0	0
Surface Coating (Misc. Manufacturing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating (Industrial Maintenance Coatings)	0	0	0	0	0	0	0	0	0	252	252	0	0	0	0	0	0	0
Surface Coating (Other Special Purpose Coatings)	0	0	0	0	0	0	0	0	0	335	335	0	0	0	0	0	0	0
Pesticides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Traffic Markings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asphalt Paving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charbroiling	220	220	220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**11,880**	**8,210**	**17,049**	**2,889**	**2,889**	**3,363**	**675**	**675**	**744**	**29,288**	**29,288**	**44,541**	**34,391**	**34,391**	**72,704**	**18,317**	**18,317**	**18,317**

Note: These numbers represent the estimated area source emissions following the procedures described in this chapter. Emissions for open burning were zeroed out for air quality modeling, and emissions for residential wood combustion were reduced for air quality modeling runs made with a burn ban in effect for Ada County.

9.0 FUTURE YEAR ON-ROAD MOBILE SOURCES

This section discusses methods for estimating future year on-road mobile source emission inventories. The general approach for the future year emissions is the same as for the 1999 emissions, discussed in Section 4. On-road mobile sources were estimated using emission factors from the EPA MOBILE6 and PART5 models, and activity data from COMPASS transportation models. Future year fugitive road dust estimates were derived by growing the 1999 estimates using vehicle miles traveled (VMT) growth factors from the COMPASS transportation modeling results.

9.1 COMPASS ACTIVITY DATA

On-road emissions estimates were generated using vehicle miles traveled (VMT) and speed estimates for each roadway in the COMPASS transportation modeling network for each of the three future years.

The 1999 model network (shown in Figure 4-1) includes road projects that were completed and open to the motoring public by December 31, 1999.

The 2010 model network includes:

- projects in the 1999 model network;
- projects under construction in 1999 through 2001 or beginning construction in 2001;
- projects listed in the Ada County Highway District's Transportation Improvement Program (TIP) FY 2002-2006 which had a construction year of 2002 through 2006 (any projects in preliminary development were not included); and
- projects listed in Idaho Transportation Department District 3's Statewide Transportation Improvement Program (STIP) FY 2002-2006 which had a construction year of 2002 through 2006 (projects in preliminary development were not included).

The 2015 Model Network includes:

- projects in the 2010 model network;
- selected projects listed in Destination 2020 – Regional Transportation Plan for Ada County, Chapter 5, page 4, Table 5-2; and
- selected projects from the TIP and STIP FY 2002-2006 that were in preliminary development.

The 2020 model network includes:

- projects in the 2015 model network;
- remaining projects listed in Destination 2020 – Regional Transportation Plan for Ada County, Chapter 5, page 4, Table 5-2 that were not added into the 2015 network; and
- remaining projects from the TIP and STIP FY 2002-2006 that were in preliminary development.

The COMPASS transportation modeling (using the TP+ model) for the future years uses the latest Census 2000 estimates of population and household demographics as the basis for projections. Figure 9-1 shows the population and households forecasts used in the future year COMPASS transportation modeling, and the resulting growth in VMT relative to year 2000 levels. Ada County VMT is projected to increase about 4.2 percent per year, and Canyon County VMT is projected to increase at about 3.5 percent per year.

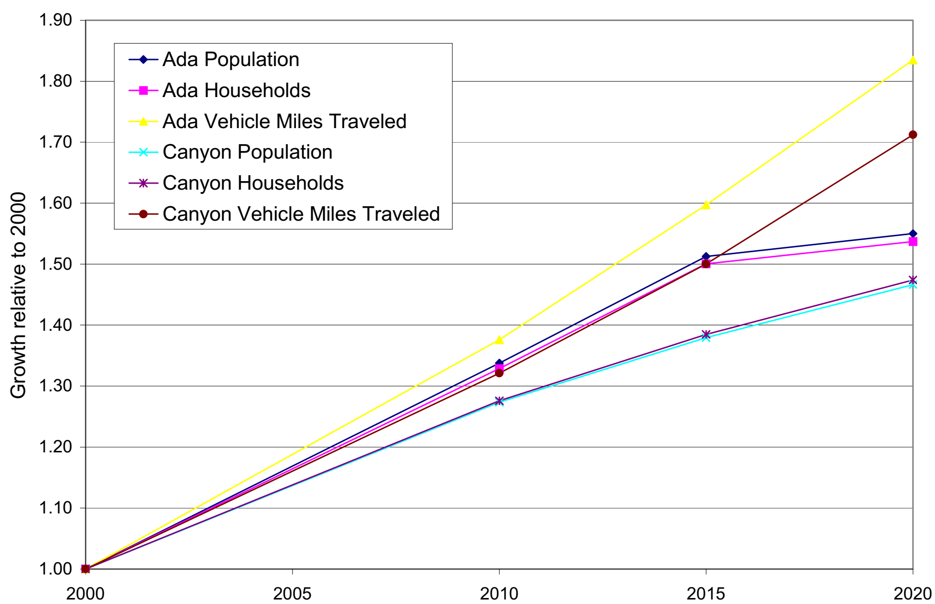

Figure 9-1. Growth factors used in future year COMPASS transportation modeling and resulting vehicle miles traveled.

As was done for the 1999 base year annual modeling, VMT was summed by roadway type and county for future year annual modeling. For the VMT total for each facility type, the average daily VMT for a six-month "summer" (April through September) and a six-month "winter" (January through March and October through December) was calculated based on monthly activity indicators supplied by COMPASS. The "summer" and "winter" emissions were then averaged to obtain the annual average.

For future year episodic modeling, emissions were calculated for each link in the COMPASS transportation network for each future year. The EXPLORA model (SAI, 1996) was used to merge the MOBILE6 and PART5 emission factors with the COMPASS link-level VMT and speeds. The results were then adjusted for December weekdays and weekends using the adjustment factors shown in Table 4-1.

9.2 MOBILE6 AND PART5 INPUTS

MOBILE6 and PART5 model inputs for the three future years are the same as those described in Section 4.2, with two exceptions, described below.

9.2.1 Temperatures and Humidity

The National Weather Service (NWS) meteorological data from the Boise airport were obtained for MOBILE6 and PART5 modeling. Thirty-year average data for the period from 1961 to 1990 were used for the 2010, 2015, and 2020 annual runs. These data were obtained from the Western Regional Climactic Center web site at http://www.wrcc.dri.edu/cgi-bin/clilcd.pl?id24131. Thirty-year average pressures and relative humidities were obtained for the MOBILE6 absolute humidity calculations. For each meteorological parameter, a weighted average was computed to represent the conditions for a six-month "summer" (April through September) and a six-month "winter" (January through March and October through December). For the episodic modeling, temperatures from the January 1991 episode (shown in Figure 1-2) were used.

9.2.2 Vehicle Fleet

As for the 1999 modeling, MOBILE6 default VMT mix and registration data were used in the modeling. Note that MOBILE6 has a dynamic vehicle mix; i.e., the splits between cars and trucks changes over time. As a result, the proportion of light-duty gasoline vehicles in future years is assumed to decrease as they are replaced by light-duty trucks (in particular, with the influx of sport utility vehicles [SUVs]), and the VMT fractions for each future year reflect this change.

MOBILE6 default VMT mix, mileage accumulation rates, and registration data equivalents were used in the PART5 modeling. MOBILE6 VMT mix specific to the each of the three future years modeled was used. Because the number of vehicle types in MOBILE6 and PART5 are different, appropriate adjustments were made by matching appropriate vehicle weight classes.

9.3 EMISSIONS BY VEHICLE CLASS

Tables 9-1 through 9-3 show the 2010, 2015, and 2020 average daily emissions by vehicle class, season, and pollutant. The relative emissions contribution of each vehicle class to the combined Ada and Canyon counties emissions for an average winter day in 2015 is shown in Figure 9-2. As shown in Figure 4-3 for 1999, the majority of VOC, CO, SO_x, and NH3 emissions are from light-duty vehicles; heavy-duty vehicles comprise about half of the on-road NO_x and PM_{10} emissions. However, in comparison to 1999 emissions, in 2015 light-duty gasoline trucks account for a much larger proportion of emissions. In addition, the proportion of heavy-duty diesel vehicle (HDDV) NO_x emissions is decreasing with the introduction of cleaner engines manufactured to meet the HDDV 2007 regulations. The proportion of HDDV PM_{10} emissions is also decreasing, even though the PART5 HDDV PM_{10} estimates do *not* incorporate the effects of the HDDV 2007 emissions regulations; this is because the proportion of PM_{10} emissions from light-duty gasoline trucks is increasing with the influx of SUVs.

Table 9-1. 2010 Average winter day, average summer day, and annual on-road emissions by vehicle class.

		Ada County						Canyon County						Ada & Canyon Counties					
Season	**Vehicle Type**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**
Summer (TPD)	LDGV	1.83	1.79	26.06	0.17	0.26	0.17	0.74	0.75	18.78	0.06	0.10	0.07	2.57	2.54	44.84	0.23	0.36	0.24
	LDGT12	2.18	2.61	34.53	0.22	0.38	0.19	0.90	1.12	23.24	0.08	0.15	0.07	3.08	3.72	57.77	0.31	0.53	0.27
	LDGT34	1.49	1.37	14.94	0.08	0.13	0.07	0.53	0.64	10.33	0.03	0.05	0.03	2.02	2.00	25.27	0.11	0.18	0.09
	HDGV	0.22	0.68	2.18	0.04	0.06	0.02	0.08	0.26	0.98	0.01	0.02	0.01	0.31	0.95	3.16	0.05	0.08	0.02
	LDDV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	LDDT	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.00
	HDDV	0.28	4.43	1.14	0.31	0.32	0.04	0.10	1.63	0.37	0.12	0.12	0.02	0.38	6.06	1.51	0.42	0.44	0.06
	MC	0.09	0.06	0.53	0.00	0.00	0.00	0.03	0.03	0.21	0.00	0.00	0.00	0.12	0.10	0.75	0.00	0.00	0.00
	Total On-road	6.11	10.94	79.39	0.81	1.16	0.50	2.38	4.44	53.92	0.31	0.44	0.19	8.49	15.38	133.31	1.12	1.59	0.69
Winter (TPD)	LDGV	1.71	1.96	42.51	0.16	0.26	0.17	0.72	0.74	18.70	0.06	0.10	0.06	2.43	2.70	61.21	0.23	0.35	0.23
	LDGT12	2.20	2.96	55.03	0.23	0.39	0.20	0.93	1.13	23.78	0.09	0.15	0.07	3.13	4.10	78.82	0.31	0.54	0.27
	LDGT34	1.54	1.67	23.87	0.08	0.13	0.07	0.57	0.64	10.50	0.03	0.05	0.03	2.11	2.31	34.37	0.11	0.18	0.09
	HDGV	0.19	0.67	2.42	0.04	0.06	0.02	0.07	0.26	0.98	0.01	0.02	0.01	0.26	0.93	3.40	0.05	0.08	0.02
	LDDV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	LDDT	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.00
	HDDV	0.27	4.09	1.05	0.31	0.32	0.04	0.09	1.62	0.37	0.12	0.12	0.02	0.37	5.70	1.42	0.42	0.44	0.06
	MC	0.08	0.08	0.60	0.00	0.00	0.00	0.03	0.03	0.21	0.00	0.00	0.00	0.11	0.11	0.81	0.00	0.00	0.00
	Total On-road	6.00	11.43	125.49	0.81	1.16	0.50	2.42	4.44	54.55	0.31	0.44	0.19	8.41	15.87	180.04	1.12	1.59	0.69
Annual (TPY)	LDGV	647	683	12514	60	94	63	266	274	6840	23	35	24	914	957	19354	83	129	87
	LDGT12	798	1016	16345	82	141	71	335	411	8582	31	54	27	1133	1427	24927	113	195	98
	LDGT34	553	554	7084	28	48	24	200	233	3800	11	18	9	753	787	10885	38	67	34
	HDGV	76	246	838	13	20	7	28	96	358	5	8	2	103	343	1196	18	28	9
	LDDV	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	LDDT	3	4	5	1	1	0	1	1	2	0	0	0	4	5	6	1	1	1
	HDDV	101	1554	399	112	117	16	35	592	136	42	44	6	136	2147	535	154	161	22
	MC	31	26	206	1	1	1	11	12	78	0	0	0	42	38	284	1	1	1
	Total On-road	2209	4084	37392	297	422	182	876	1620	19796	112	160	69	3085	5703	57188	410	581	251

Table 9-2. 2015 Average winter day, average summer day, and annual on-road emissions by vehicle class.

		Ada County						Canyon County						Ada & Canyon Counties					
Season	**Vehicle Type**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**
Summer (TPD)	LDGV	1.19	1.16	22.22	0.17	0.26	0.18	0.48	0.47	16.28	0.06	0.10	0.06	1.67	1.63	38.50	0.23	0.36	0.24
	LDGT12	1.96	2.17	35.71	0.28	0.48	0.24	0.80	0.88	23.77	0.10	0.18	0.09	2.76	3.05	59.47	0.39	0.66	0.34
	LDGT34	1.38	1.31	15.43	0.10	0.17	0.08	0.48	0.58	10.62	0.04	0.06	0.03	1.86	1.89	26.06	0.13	0.23	0.12
	HDGV	0.18	0.39	2.19	0.04	0.06	0.02	0.06	0.15	0.98	0.02	0.02	0.01	0.24	0.53	3.18	0.06	0.09	0.03
	LDDV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	LDDT	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.00
	HDDV	0.25	2.48	0.61	0.33	0.37	0.05	0.09	0.90	0.20	0.12	0.14	0.02	0.34	3.38	0.81	0.45	0.50	0.07
	MC	0.10	0.07	0.62	0.00	0.00	0.00	0.04	0.04	0.24	0.00	0.00	0.00	0.14	0.11	0.85	0.00	0.00	0.00
	Total On-road	5.06	7.59	76.80	0.92	1.35	0.58	1.96	3.02	52.09	0.34	0.50	0.21	7.02	10.60	128.89	1.27	1.85	0.79
Winter (TPD)	LDGV	1.15	1.27	37.84	0.17	0.26	0.17	0.49	0.47	16.32	0.06	0.10	0.06	1.64	1.74	54.16	0.23	0.36	0.24
	LDGT12	1.93	2.41	56.89	0.28	0.49	0.25	0.82	0.89	24.21	0.11	0.18	0.09	2.75	3.30	81.10	0.39	0.67	0.34
	LDGT34	1.37	1.57	24.75	0.10	0.17	0.08	0.51	0.58	10.75	0.04	0.06	0.03	1.88	2.15	35.49	0.13	0.23	0.11
	HDGV	0.15	0.38	2.54	0.04	0.06	0.02	0.05	0.14	0.98	0.02	0.02	0.01	0.20	0.52	3.53	0.06	0.09	0.03
	LDDV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	LDDT	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.00
	HDDV	0.25	2.34	0.57	0.33	0.37	0.05	0.08	0.89	0.19	0.12	0.14	0.02	0.33	3.23	0.77	0.45	0.50	0.07
	MC	0.09	0.09	0.69	0.00	0.00	0.00	0.03	0.03	0.23	0.00	0.00	0.00	0.13	0.12	0.92	0.00	0.00	0.00
	Total On-road	4.95	8.06	123.29	0.92	1.35	0.58	1.99	3.02	52.69	0.34	0.50	0.21	6.94	11.08	175.98	1.27	1.85	0.79
Annual (TPY)	LDGV	427	443	10961	61	95	64	177	172	5950	23	35	24	604	615	16910	83	130	87
	LDGT12	710	835	16898	103	177	90	296	324	8756	38	66	33	1006	1158	25654	141	243	123
	LDGT34	502	526	7333	35	61	31	181	212	3900	13	22	11	683	738	11233	48	83	42
	HDGV	59	139	865	15	23	8	21	53	358	6	9	3	80	192	1223	21	32	10
	LDDV	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	LDDT	2	3	5	1	1	0	1	1	2	0	0	0	3	4	6	2	1	1
	HDDV	92	880	216	121	134	18	31	327	71	45	50	7	123	1207	288	166	184	25
	MC	36	30	238	1	1	1	13	13	86	0	0	0	48	43	324	1	1	2
	Total On-road	1827	2856	36516	337	493	211	719	1101	19123	125	182	78	2547	3957	55640	462	675	289

Table 9-3. 2020 Average winter day, average summer day, and annual on-road emissions by vehicle class.

		Ada County						Canyon County						Ada & Canyon Counties					
Season	**Vehicle Type**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**
Summer (TPD)	LDGV	0.94	0.89	20.19	0.18	0.28	0.19	0.39	0.37	15.33	0.07	0.10	0.07	1.33	1.25	35.52	0.24	0.38	0.25
	LDGT12	1.85	2.03	37.65	0.34	0.58	0.29	0.78	0.83	25.35	0.12	0.21	0.11	2.63	2.86	63.01	0.46	0.79	0.40
	LDGT34	1.23	1.24	16.20	0.11	0.20	0.10	0.43	0.55	11.24	0.04	0.07	0.04	1.66	1.79	27.44	0.16	0.27	0.14
	HDGV	0.14	0.24	2.54	0.05	0.07	0.02	0.05	0.09	1.11	0.02	0.03	0.01	0.19	0.33	3.64	0.07	0.10	0.03
	LDDV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	LDDT	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.00	0.00
	HDDV	0.27	1.44	0.43	0.38	0.43	0.06	0.09	0.51	0.14	0.14	0.16	0.02	0.36	1.96	0.56	0.52	0.58	0.08
	MC	0.12	0.08	0.70	0.00	0.00	0.00	0.04	0.04	0.27	0.00	0.00	0.00	0.16	0.12	0.97	0.00	0.00	0.00
	Total On-road	4.56	5.92	77.72	1.06	1.56	0.67	1.78	2.40	53.44	0.39	0.57	0.24	6.34	8.32	131.17	1.45	2.14	0.91
Winter (TPD)	LDGV	0.96	1.01	36.32	0.18	0.28	0.19	0.42	0.37	15.57	0.07	0.10	0.07	1.38	1.38	51.89	0.24	0.38	0.25
	LDGT12	1.83	2.30	60.43	0.34	0.58	0.29	0.80	0.84	25.73	0.12	0.21	0.11	2.63	3.14	86.16	0.46	0.80	0.40
	LDGT34	1.24	1.51	25.88	0.11	0.20	0.10	0.46	0.55	11.32	0.04	0.07	0.04	1.70	2.07	37.20	0.16	0.27	0.14
	HDGV	0.12	0.23	2.95	0.05	0.07	0.02	0.04	0.09	1.11	0.02	0.03	0.01	0.16	0.32	4.05	0.07	0.10	0.03
	LDDV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	LDDT	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.00	0.00
	HDDV	0.27	1.35	0.41	0.38	0.42	0.06	0.09	0.51	0.13	0.14	0.16	0.02	0.36	1.86	0.54	0.52	0.58	0.08
	MC	0.10	0.10	0.78	0.00	0.00	0.00	0.04	0.04	0.26	0.00	0.00	0.00	0.14	0.14	1.04	0.00	0.00	0.00
	Total On-road	4.53	6.51	126.78	1.06	1.56	0.66	1.84	2.40	54.12	0.39	0.57	0.24	6.37	8.91	180.91	1.45	2.13	0.91
Annual (TPY)	LDGV	348	347	10313	65	101	68	147	135	5639	24	37	25	494	481	15952	89	138	93
	LDGT12	672	789	17900	122	212	107	287	305	9322	45	78	39	960	1094	27223	168	290	146
	LDGT34	451	503	7679	42	73	36	163	201	4118	15	27	13	614	704	11797	57	99	50
	HDGV	49	86	1001	18	27	9	17	33	404	7	10	3	65	119	1405	24	37	12
	LDDV	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	LDDT	2	2	5	2	1	1	1	1	2	1	0	0	3	3	7	2	2	1
	HDDV	98	509	152	138	155	21	32	187	49	51	57	8	131	696	201	189	212	29
	MC	40	33	271	1	1	1	14	14	96	0	0	0	54	47	367	1	1	2
	Total On-road	1660	2268	37322	388	570	243	661	876	19631	143	209	89	2321	3144	56953	531	779	332

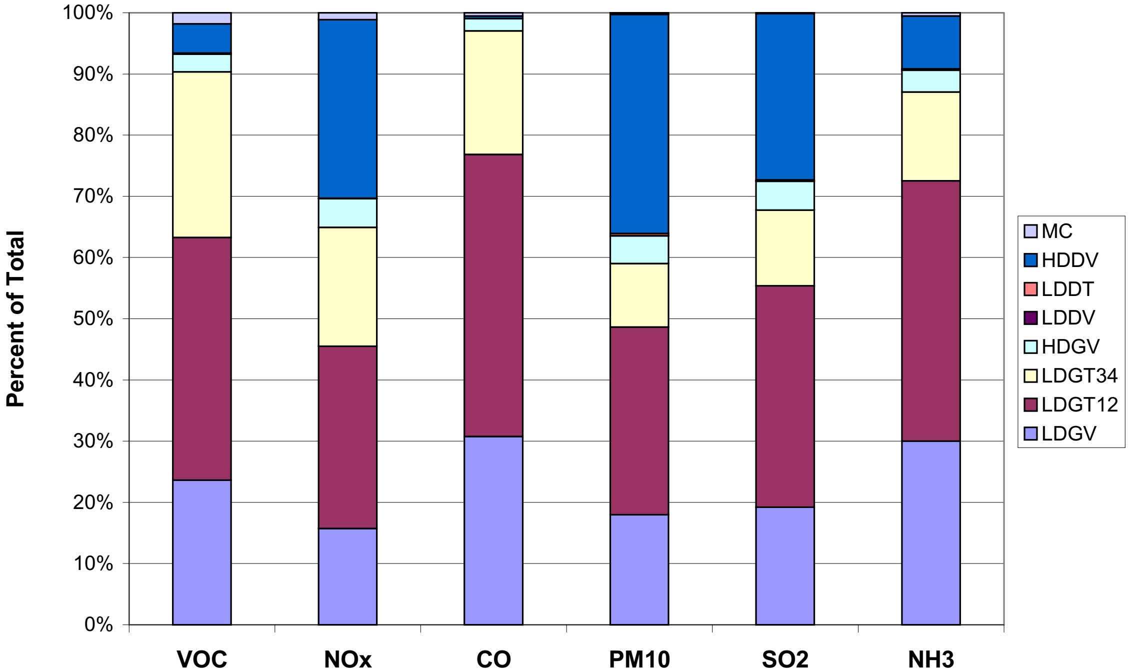

Figure 9-2. Contribution to 2015 average winter day on-road emissions by vehicle class (Ada & Canyon counties).

9.4 FUGITIVE ROAD DUST EMISSIONS

Future year paved and unpaved road fugitive dust emissions were estimated using the same approach as for the 1999 base year, as described in Section 4.4. The future year activity estimates from the COMPASS transportation modeling were used in conjunction with TRAKER street surveys to estimate the road dust emissions inventory for the Treasure Valley for each of the three future years. The road dust emission inventories thus grow from 1999 levels (shown in Table 4-5) in proportion to the growth in VMT shown in Figure 9-1.

9.5 DATA MANAGEMENT AND QUALITY ASSURANCE/QUALITY CONTROL

In general, procedures described in *Final Inventory Preparation Plan/Quality Assurance Plan (IPP/QAP)* (ENVIRON, 2001) were used to check, and correct when necessary, the future year on-road mobile sources emissions estimates. All MOBILE6 and PART5 input and output files, and Excel spreadsheets used to calculate the emissions, were checked by personnel who were not involved in the development of the modeling inputs/outputs and spreadsheets. Fugitive road dust emissions were checked by comparing totals in the DRI spreadsheets to the output of the EXPLORA model. In addition, the emissions estimates were reviewed for reasonableness by IDEQ staff and external stakeholders.

10.0 FUTURE YEAR OFF-ROAD MOBILE SOURCES

This section discusses methods for estimating future year off-road mobile source emission inventories. The general approach was to apply growth factors to account for growth in off-road equipment populations from 1999 base year populations, and use the EPA NONROAD model to derive emission factors that include the effects of Federal off-road equipment control programs. This section describes the growth factors used and the modeling approach, and provides tabular summaries of future year off-road emission inventories by off-road source category.

10.1 OFF-ROAD GROWTH FACTORS

Growth factors for off-road mobiles sources are based on the Emission Inventory Improvement Program (EIIP) projections guidance (EIIP, 1999). The EIIP guidance states that growth indicators should closely approximate the change in emission source activity. Three criteria are listed in EIIP for choosing an appropriate growth indicator:

- consistency with the activity indicator used to estimate base year emissions,
- consistency with the activity which generates emissions, and
- geographic consistency (local or state data preferred).

The growth factors selected for off-road mobile sources are listed in Table 10-1; the data for these growth factors are shown in Table 10-2. These growth factors meet the EIIP criteria, and were reviewed and approved by EPA Region X.

Table 10-1. Growth indicators for off-road sources in Ada and Canyon Counties.

Source Category	Growth Indicator	Source
Agricultural	Agricultural Land Use Trends	Belzer, 2002
Commercial Aircraft/Ground Support Equipment (GSE)	Federal Aviation Administration (FAA) landings and takeoffs (LTO) forecasts for Boise Air Terminal	Http://www.apo.data.faa.gov/faatafall.HTM
General aviation	Air Transportation GSP for Idaho	BEA, 2001
Military aircraft	No growth	CH2MHill, 1996; SAI, 1997
Commercial	Total employment forecasts by county	COMPASS, 2001
Industrial	Total employment forecasts by county	COMPASS, 2001
Construction	Total non-agricultural employment forecasts by county	COMPASS, 2001
Lawn & Garden	Households forecasts by county	COMPASS, 2001
Locomotives & Railroad	No growth	IDEQ, 1999
Pleasure Craft	Population forecasts by county	COMPASS, 2001
Recreational equipment	Population forecasts by county	COMPASS, 2001

Table 10-2. Future year growth factors and surrogates for off-road emissions.

Ada County Surrogate	1999	2010	2015	2020	Growth relative to 1999 2010	2015	2020
Agricultural Land Use Trends	195,975	193,315	191,985	190,655	0.986	0.979	0.973
Boise Air Terminal LTO forecasts (no. of cycles)	1,118,086	1,422,731	1,561,206	1,699,681	1.272	1.396	1.520
Air Transportation GSP for Idaho (million $)	106	162	187	212	1.522	1.759	1.996
Total employment forecasts (no. of persons)	199,021	255,937	282,291	307,391	1.286	1.418	1.545
Total non-agricultural employment forecasts (no. of persons)	199,021	255,937	282,291	307,391	1.286	1.418	1.545
Households forecasts (no. of homes)	113,408	150,691	170,170	174,321	1.329	1.501	1.537
Population forecasts (no. of persons)	300,904	402,500	455,171	466,403	1.338	1.513	1.550

Canyon County Surrogate	1999	2010	2015	2020	Growth relative to 1999 2010	2015	2020
Agricultural Land Use Trends	264,991	256,971	252,961	248,951	0.968	0.954	0.939
Boise Air Terminal LTO forecasts (no. of cycles)	1,118,086	1,422,731	1,561,206	1,699,681	1.272	1.396	1.520
Air Transportation GSP for Idaho (million $)	106	162	187	212	1.522	1.759	1.996
Total employment forecasts (no. of persons)	45,328	54,056	58,438	64,380	1.193	1.289	1.420
Total non-agricultural employment forecasts (no. of persons)	43,295	52,142	56,580	62,582	1.204	1.307	1.445
Households forecasts (no. of homes)	45,018	57,435	62,343	66,355	1.276	1.385	1.474
Population forecasts (no. of persons)	131,441	167,416	181,313	192,738	1.274	1.379	1.466

10.2 METHODOLOGY

10.2.1 Control Factors

To estimate future year emissions, control factors are needed in addition to growth factors. For so-called traditional non-road equipment (all non-road except aircraft, locomotive, and commercial marine), the EPA NONROAD model includes the effects of all Federal control programs for traditional non-road sources. Specifically, NONROAD model incorporates the effects of the emission standards through a dynamic age distribution calculation. The national non-road emission standards included in the model are:

- Diesel engines,
- Small gasoline engines (handheld and nonhandheld equipment $<$25 hp),
- Recreational marine gasoline engines, and
- Recreational and commercial marine diesel engines.

No reductions are assumed for aircraft emission factors. The International Civil Aviation Organization (ICAO) has promulgated NO_x and CO emission standards for commercial aircraft. The Regulatory Support Document (RSD) for the ICAO standard indicates that all applicable engines covered by the CO standard and the first-stage NO_x standard currently meet the standard. A second-stage NO_x standard is 20 percent lower than the first-stage standard, but NO_x emission reductions for the second-stage standard are small, and the majority of engines in use are already meeting this standard.

10.2.2 NONROAD Modeling

NONROAD modeling procedures for developing future year inventories were identical to the procedures used to estimate emissions for the 1999 base year, as described in Section 5, except for the following:

- Gasoline sulfur levels were set to 30 ppm for the years 2010, 2015, and 2020 in accordance with EPA's Tier 2 regulations.

- For annual emissions estimates, 30-year average temperatures recorded by the National Weather Service at the Boise Air Terminal (available athttp://www.wrcc.dri.edu/cgi-bin/clilcd.pl?id24131). The annual emissions estimates were derived by first estimating average summer day and average winter day emissions, and then averaging the summer and winter estimates. The NWS temperatures for or a six-month "summer" (April through September) and a six-month "winter" (January through March and October through December) were used in the summer and winter modeling, respectively. For the episodic modeling, temperatures from the January 1991 episode (shown in Figure 1-2) were used.

- Snowmobile populations were zeroed out for both the annual and episodic emission inventories, as snow levels are too low. (In the next version of the NONROAD model to be released, snowmobiles will be allocated only to counties with at least 40 inches of average annual snowfall; Boise has only 21 inches.) Although there was 7" of snow on the ground in the 1991 episode, there is very little snowmobile usage in the two counties, there is virtually no snowmobile usage in Ada and Canyon counties. Snowblower equipment populations were not altered from the NONROAD default estimates.

The NONROAD model was run at zero growth (i.e., same as the base year); and the growth factors were applied outside the model.

10.3 EMISSIONS BY SOURCE CATEGORY

Tables 10-3 through 10-5 show the 2010, 2015, and 2020 average daily emissions by vehicle class, season, and pollutant. The relative emissions contribution of each vehicle class to the combined Ada and Canyon counties emissions for an average winter day in 1999 is shown in Figure 10-1. The relative contributions by source category are very similar to those in the base year: Off-road categories with sizeable PM_{10} emissions are construction and mining equipment, lawn and garden equipment, industrial equipment, and agricultural equipment. VOC emissions are dominated by lawn and garden equipment. The largest contributors to SO_x and ammonia emission are estimated to be construction and mining equipment, and industrial and commercial equipment.

Table 10-3. 2010 Average winter day, average summer day, and annual off-road emissions by source category.

		Ada County						Canyon County						Ada & Canyon Counties				
Season	**Source Category**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**
Summer (TPD)	Agricultural Equipment	0.271	1.859	3.009	0.185	0.744	0.004	0.499	4.063	4.501	0.362	1.610	0.007	0.770	5.922	7.510	0.547	2.354
	Aircraft	0.936	0.517	17.075	0.045	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.936	0.517	17.075	0.045	0.060
	Airport Ground Support Equipment	0.353	0.233	7.299	0.011	0.032	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.353	0.233	7.299	0.011	0.032
	Commercial Equipment	0.489	0.663	22.081	0.086	0.213	0.002	0.122	0.165	5.504	0.021	0.053	0.001	0.611	0.828	27.584	0.107	0.266
	Construction and Mining Equipment	0.632	4.708	8.689	0.551	2.710	0.011	0.143	1.065	1.965	0.124	0.613	0.002	0.775	5.773	10.653	0.675	3.323
	Industrial Equipment	0.216	1.821	8.694	0.161	0.613	0.007	0.095	0.806	3.900	0.068	0.261	0.003	0.311	2.627	12.594	0.228	0.873
	Lawn and Garden Equipment (Com)	3.674	1.473	116.643	0.354	0.457	0.006	0.283	0.114	8.986	0.027	0.035	0.000	3.957	1.587	125.629	0.381	0.492
	Lawn and Garden Equipment (Res)	0.831	0.118	24.640	0.021	0.002	0.001	0.328	0.047	9.742	0.008	0.001	0.000	1.159	0.165	34.382	0.029	0.003
	Locomotives	0.058	1.400	0.140	0.036	0.130	0.001	0.020	0.466	0.047	0.011	0.043	0.000	0.078	1.866	0.186	0.047	0.173
	Logging Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pleasure Craft	0.200	0.027	0.772	0.011	0.006	0.000	0.513	0.070	1.980	0.029	0.014	0.000	0.713	0.097	2.752	0.040	0.020
	Railroad Equipment	0.001	0.005	0.019	0.001	0.004	0.000	0.000	0.002	0.008	0.000	0.002	0.000	0.001	0.008	0.027	0.001	0.005
	Recreational Equipment	0.718	0.081	10.981	0.015	0.012	0.001	0.176	0.021	3.033	0.004	0.003	0.000	0.894	0.102	14.015	0.018	0.014
	Total Non-road	8.378	12.906	220.041	1.475	4.981	0.032	2.180	6.818	39.665	0.655	2.634	0.015	10.558	19.724	259.707	2.130	7.615
Winter (TPD)	Agricultural Equipment	0.051	0.226	0.354	0.022	0.091	0.000	0.087	0.491	0.531	0.044	0.197	0.001	0.138	0.716	0.885	0.067	0.288
	Aircraft	0.936	0.517	17.075	0.045	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.936	0.517	17.075	0.045	0.060
	Airport Ground Support Equipment	0.374	0.282	7.127	0.011	0.033	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.374	0.282	7.127	0.011	0.033
	Commercial Equipment	0.511	0.702	21.575	0.087	0.218	0.002	0.127	0.175	5.378	0.022	0.054	0.001	0.639	0.877	26.952	0.109	0.272
	Construction and Mining Equipment	0.152	1.084	2.026	0.129	0.639	0.003	0.034	0.245	0.458	0.029	0.145	0.001	0.187	1.329	2.484	0.158	0.784
	Industrial Equipment	0.155	1.249	5.877	0.110	0.420	0.005	0.068	0.553	2.636	0.046	0.179	0.002	0.223	1.803	8.514	0.156	0.599
	Lawn and Garden Equipment (Com)	4.024	0.532	30.244	0.193	0.077	0.002	0.310	0.041	2.330	0.015	0.006	0.000	4.334	0.573	32.574	0.208	0.083
	Lawn and Garden Equipment (Res)	0.802	0.071	5.829	0.025	0.001	0.000	0.317	0.028	2.305	0.010	0.000	0.000	1.118	0.100	8.134	0.034	0.001
	Locomotives	0.058	1.400	0.140	0.036	0.130	0.001	0.020	0.466	0.047	0.011	0.043	0.000	0.078	1.866	0.186	0.047	0.173
	Logging Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pleasure Craft	0.046	0.003	0.065	0.001	0.000	0.000	0.118	0.007	0.168	0.002	0.001	0.000	0.164	0.009	0.233	0.003	0.002
	Railroad Equipment	0.001	0.005	0.019	0.001	0.004	0.000	0.000	0.002	0.008	0.000	0.002	0.000	0.001	0.008	0.027	0.001	0.005
	Recreational Equipment	0.271	0.024	2.962	0.004	0.003	0.000	0.066	0.006	0.820	0.001	0.001	0.000	0.338	0.031	3.782	0.005	0.004
	Total Non-road	7.380	6.095	93.292	0.663	1.676	0.014	1.149	2.015	14.680	0.181	0.628	0.005	8.529	8.110	107.972	0.844	2.303
Annual (TPY)	Agricultural Equipment	59	381	615	38	153	1	107	833	920	74	331	2	166	1214	1536	112	483
	Aircraft	342	189	6232	16	22	0	0	0	0	0	0	0	342	189	6232	16	22
	Airport Ground Support Equipment	133	94	2633	4	12	0	0	0	0	0	0	0	133	94	2633	4	12
	Commercial Equipment	183	249	7967	32	79	1	46	62	1986	8	20	0	228	311	9953	39	98
	Construction and Mining Equipment	143	1059	1959	124	612	2	32	239	443	28	138	1	176	1298	2402	152	751
	Industrial Equipment	68	561	2661	49	189	2	30	248	1194	21	80	1	98	809	3854	70	269
	Lawn and Garden Equipment (Com)	1405	366	26850	100	98	1	108	28	2069	8	8	0	1513	395	28919	108	105
	Lawn and Garden Equipment (Res)	298	35	5570	8	0	0	118	14	2202	3	0	0	416	48	7772	12	1
	Locomotives	21	511	51	13	47	0	7	170	17	4	16	0	28	681	68	17	63
	Logging Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pleasure Craft	45	5	153	2	1	0	115	14	393	6	3	0	160	19	546	8	4
	Railroad Equipment	0	2	7	0	1	0	0	1	3	0	1	0	0	3	10	0	2
	Recreational Equipment	181	19	2549	3	3	0	44	5	704	1	1	0	225	24	3253	4	3
	Total Non-road	2876	3471	57247	391	1217	8	608	1614	9931	153	596	4	3484	5085	67177	543	1813

Table 10-4. 2015 Average winter day, average summer day, and annual off-road emissions by source category.

		Ada County						Canyon County						Ada & Canyon Counties				
Season	**Source Category**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**
Summer (TPD)	Agricultural Equipment	0.225	1.497	2.974	0.170	0.740	0.003	0.399	3.173	4.399	0.327	1.588	0.007	0.624	4.670	7.373	0.497	2.328
	Aircraft	0.963	0.559	17.346	0.050	0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.963	0.559	17.346	0.050	0.064
	Airport Ground Support Equipment	0.385	0.241	8.008	0.011	0.035	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.385	0.241	8.008	0.011	0.035
	Commercial Equipment	0.505	0.644	24.441	0.090	0.239	0.003	0.123	0.157	5.971	0.022	0.058	0.001	0.628	0.802	30.412	0.112	0.298
	Construction and Mining Equipment	0.551	3.973	9.563	0.570	2.993	0.012	0.123	0.884	2.127	0.127	0.666	0.003	0.673	4.857	11.690	0.697	3.658
	Industrial Equipment	0.212	1.872	9.597	0.171	0.681	0.008	0.092	0.814	4.219	0.071	0.284	0.003	0.304	2.686	13.816	0.242	0.965
	Lawn and Garden Equipment (Com)	3.952	1.550	131.609	0.393	0.516	0.006	0.293	0.115	9.746	0.029	0.038	0.000	4.244	1.665	141.355	0.422	0.554
	Lawn and Garden Equipment (Res)	0.776	0.121	27.823	0.023	0.002	0.001	0.295	0.046	10.573	0.009	0.001	0.000	1.071	0.167	38.396	0.031	0.003
	Locomotives	0.058	1.400	0.140	0.036	0.130	0.001	0.020	0.466	0.047	0.011	0.043	0.000	0.078	1.866	0.186	0.047	0.173
	Logging Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pleasure Craft	0.184	0.032	0.858	0.012	0.006	0.000	0.452	0.078	2.106	0.029	0.015	0.000	0.636	0.109	2.963	0.040	0.022
	Railroad Equipment	0.001	0.004	0.019	0.001	0.004	0.000	0.000	0.002	0.008	0.000	0.002	0.000	0.001	0.006	0.027	0.001	0.005
	Recreational Equipment	0.808	0.085	12.415	0.016	0.013	0.001	0.190	0.021	3.284	0.004	0.003	0.000	0.997	0.106	15.699	0.020	0.016
	Total Non-road	8.619	11.979	244.791	1.542	5.423	0.035	1.987	5.755	42.481	0.628	2.698	0.015	10.606	17.735	287.272	2.170	8.122
Winter (TPD)	Agricultural Equipment	0.046	0.183	0.350	0.021	0.091	0.000	0.075	0.386	0.519	0.040	0.194	0.001	0.121	0.569	0.869	0.061	0.285
	Aircraft	0.963	0.559	17.346	0.050	0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.963	0.559	17.346	0.050	0.064
	Airport Ground Support Equipment	0.408	0.296	7.819	0.011	0.036	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.408	0.296	7.819	0.011	0.036
	Commercial Equipment	0.532	0.688	23.880	0.092	0.245	0.003	0.130	0.168	5.834	0.022	0.060	0.001	0.661	0.856	29.714	0.115	0.305
	Construction and Mining Equipment	0.137	0.930	2.231	0.134	0.706	0.003	0.030	0.207	0.496	0.030	0.157	0.001	0.167	1.137	2.727	0.164	0.863
	Industrial Equipment	0.154	1.291	6.487	0.117	0.466	0.005	0.067	0.562	2.852	0.048	0.194	0.002	0.220	1.853	9.340	0.165	0.661
	Lawn and Garden Equipment (Com)	4.522	0.577	34.139	0.216	0.087	0.002	0.335	0.043	2.528	0.016	0.006	0.000	4.857	0.619	36.667	0.232	0.093
	Lawn and Garden Equipment (Res)	0.885	0.079	6.581	0.028	0.001	0.000	0.336	0.030	2.501	0.010	0.000	0.000	1.222	0.109	9.081	0.038	0.001
	Locomotives	0.058	1.400	0.140	0.036	0.130	0.001	0.020	0.466	0.047	0.011	0.043	0.000	0.078	1.866	0.186	0.047	0.173
	Logging Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pleasure Craft	0.049	0.003	0.073	0.001	0.001	0.000	0.119	0.007	0.179	0.002	0.001	0.000	0.168	0.010	0.251	0.003	0.002
	Railroad Equipment	0.001	0.004	0.018	0.001	0.004	0.000	0.000	0.002	0.008	0.000	0.002	0.000	0.001	0.006	0.026	0.001	0.005
	Recreational Equipment	0.306	0.026	3.348	0.005	0.003	0.000	0.071	0.007	0.888	0.001	0.001	0.000	0.377	0.032	4.237	0.006	0.004
	Total Non-road	8.059	6.036	102.412	0.711	1.833	0.015	1.184	1.877	15.852	0.182	0.659	0.005	9.243	7.912	118.264	0.893	2.492
Annual (TPY)	Agricultural Equipment	50	307	608	35	152	1	87	651	900	67	326	2	136	958	1507	102	478
	Aircraft	351	204	6331	18	24	0	0	0	0	0	0	0	351	204	6331	18	24
	Airport Ground Support Equipment	145	98	2888	4	13	0	0	0	0	0	0	0	145	98	2888	4	13
	Commercial Equipment	189	243	8819	33	88	1	46	59	2155	8	22	0	235	303	10973	41	110
	Construction and Mining Equipment	126	896	2156	129	676	3	28	199	480	29	150	1	154	1096	2636	158	827
	Industrial Equipment	67	578	2937	53	209	2	29	251	1291	22	87	1	96	829	4228	74	297
	Lawn and Garden Equipment (Com)	1546	389	30298	111	110	2	115	29	2244	8	8	0	1661	417	32541	119	118
	Lawn and Garden Equipment (Res)	303	37	6289	9	1	0	115	14	2390	3	0	0	418	50	8679	13	1
	Locomotives	21	511	51	13	47	0	7	170	17	4	16	0	28	681	68	17	63
	Logging Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pleasure Craft	43	6	170	2	1	0	104	16	418	6	3	0	147	22	588	8	4
	Railroad Equipment	0	1	7	0	1	0	0	1	3	0	1	0	0	2	10	0	2
	Recreational Equipment	203	20	2881	4	3	0	48	5	763	1	1	0	251	25	3644	5	4
	Total Non-road	3044	3291	63436	412	1326	9	579	1395	10659	148	614	4	3623	4686	74095	560	1940

Table 10-5. 2020 Average winter day, average summer day, and annual off-road emissions by source category.

		Ada County						Canyon County						Ada & Canyon Counties				
Season	**Source Category**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**	**NH3**	**VOC**	**NOx**	**CO**	**PM10**	**SO2**
Summer (TPD)	Agricultural Equipment	0.203	1.297	2.951	0.163	0.736	0.003	0.347	2.675	4.325	0.308	1.565	0.007	0.549	3.972	7.276	0.471	2.301
	Aircraft	0.990	0.602	17.617	0.056	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990	0.602	17.617	0.056	0.069
	Airport Ground Support Equipmen	0.418	0.256	8.717	0.011	0.038	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.418	0.256	8.717	0.011	0.038
	Commercial Equipment	0.536	0.647	26.639	0.096	0.262	0.003	0.132	0.160	6.584	0.024	0.065	0.001	0.668	0.807	33.223	0.120	0.327
	Construction and Mining Equipment	0.564	3.985	10.418	0.612	3.260	0.013	0.128	0.900	2.354	0.138	0.737	0.003	0.692	4.885	12.772	0.751	3.997
	Industrial Equipment	0.220	1.989	10.453	0.184	0.742	0.008	0.097	0.876	4.649	0.077	0.313	0.004	0.317	2.864	15.102	0.261	1.055
	Lawn and Garden Equipment (Com)	4.038	1.541	134.825	0.401	0.529	0.006	0.311	0.119	10.374	0.031	0.041	0.000	4.349	1.660	145.198	0.432	0.569
	Lawn and Garden Equipment (Res)	0.781	0.123	28.494	0.023	0.002	0.001	0.308	0.049	11.251	0.009	0.001	0.000	1.089	0.172	39.745	0.032	0.003
	Locomotives	0.058	1.400	0.140	0.036	0.130	0.001	0.020	0.466	0.047	0.011	0.043	0.000	0.078	1.866	0.186	0.047	0.173
	Logging Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pleasure Craft	0.168	0.033	0.873	0.012	0.006	0.000	0.429	0.084	2.225	0.029	0.016	0.000	0.597	0.117	3.098	0.041	0.023
	Railroad Equipment	0.001	0.003	0.019	0.001	0.004	0.000	0.000	0.002	0.008	0.000	0.002	0.000	0.001	0.005	0.027	0.001	0.005
	Recreational Equipment	0.825	0.082	12.725	0.016	0.013	0.001	0.201	0.022	3.492	0.004	0.003	0.000	1.026	0.104	16.217	0.020	0.017
	Total Non-road	8.801	11.958	253.870	1.610	5.791	0.037	1.973	5.351	45.308	0.632	2.785	0.016	10.774	17.310	299.178	2.242	8.576
Winter (TPD)	Agricultural Equipment	0.043	0.158	0.344	0.020	0.089	0.000	0.068	0.324	0.505	0.037	0.189	0.001	0.111	0.482	0.849	0.057	0.279
	Aircraft	0.990	0.602	17.617	0.056	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990	0.602	17.617	0.056	0.069
	Airport Ground Support Equipmen	0.438	0.312	8.418	0.012	0.038	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.438	0.312	8.418	0.012	0.038
	Commercial Equipment	0.560	0.688	25.738	0.097	0.265	0.003	0.138	0.170	6.362	0.024	0.066	0.001	0.698	0.859	32.099	0.121	0.331
	Construction and Mining Equipment	0.140	0.931	2.403	0.143	0.761	0.003	0.032	0.210	0.543	0.032	0.172	0.001	0.172	1.141	2.946	0.175	0.932
	Industrial Equipment	0.158	1.359	6.988	0.124	0.503	0.006	0.070	0.599	3.108	0.052	0.212	0.003	0.228	1.958	10.096	0.177	0.715
	Lawn and Garden Equipment (Com)	4.580	0.570	34.585	0.218	0.088	0.002	0.352	0.044	2.661	0.017	0.007	0.000	4.933	0.613	37.246	0.235	0.095
	Lawn and Garden Equipment (Res)	0.896	0.080	6.666	0.028	0.001	0.000	0.354	0.032	2.632	0.011	0.000	0.000	1.250	0.111	9.298	0.039	0.001
	Locomotives	0.058	1.400	0.140	0.036	0.130	0.001	0.020	0.466	0.047	0.011	0.043	0.000	0.078	1.866	0.186	0.047	0.173
	Logging Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pleasure Craft	0.048	0.003	0.073	0.001	0.001	0.000	0.122	0.008	0.187	0.003	0.001	0.000	0.170	0.011	0.260	0.003	0.002
	Railroad Equipment	0.001	0.004	0.018	0.001	0.004	0.000	0.000	0.002	0.008	0.000	0.002	0.000	0.001	0.005	0.026	0.001	0.005
	Recreational Equipment	0.310	0.025	3.394	0.005	0.003	0.000	0.075	0.007	0.934	0.001	0.001	0.000	0.386	0.031	4.328	0.006	0.004
	Total Non-road	8.223	6.132	106.384	0.739	1.951	0.016	1.232	1.861	16.986	0.188	0.693	0.005	9.455	7.992	123.371	0.928	2.644
Annual (TPY)	Agricultural Equipment	45	266	603	33	151	1	76	549	884	63	321	1	121	815	1487	97	472
	Aircraft	362	220	6448	20	25	0	0	0	0	0	0	0	362	220	6448	20	25
	Airport Ground Support Equipmen	157	104	3136	4	14	0	0	0	0	0	0	0	157	104	3136	4	14
	Commercial Equipment	201	244	9585	35	96	1	50	60	2369	9	24	0	250	305	11954	44	120
	Construction and Mining Equipment	129	900	2346	138	736	3	29	203	530	31	166	1	158	1103	2876	169	902
	Industrial Equipment	69	613	3192	56	228	3	30	270	1420	24	96	1	100	882	4611	80	324
	Lawn and Garden Equipment (Com)	1577	386	31002	113	113	2	121	30	2385	9	9	0	1699	416	33387	122	122
	Lawn and Garden Equipment (Res)	307	37	6434	9	1	0	121	15	2541	4	0	0	428	52	8975	13	1
	Locomotives	21	512	51	13	47	0	7	170	17	4	16	0	29	683	68	17	63
	Logging Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pleasure Craft	40	7	173	2	1	0	101	17	441	6	3	0	140	23	615	8	4
	Railroad Equipment	0	1	7	0	1	0	0	1	3	0	1	0	0	2	10	0	2
	Recreational Equipment	208	20	2950	4	3	0	51	5	810	1	1	0	258	25	3760	5	4
	Total Non-road	3115	3311	65927	430	1417	10	586	1320	11400	150	636	4	3702	4630	77326	580	2053

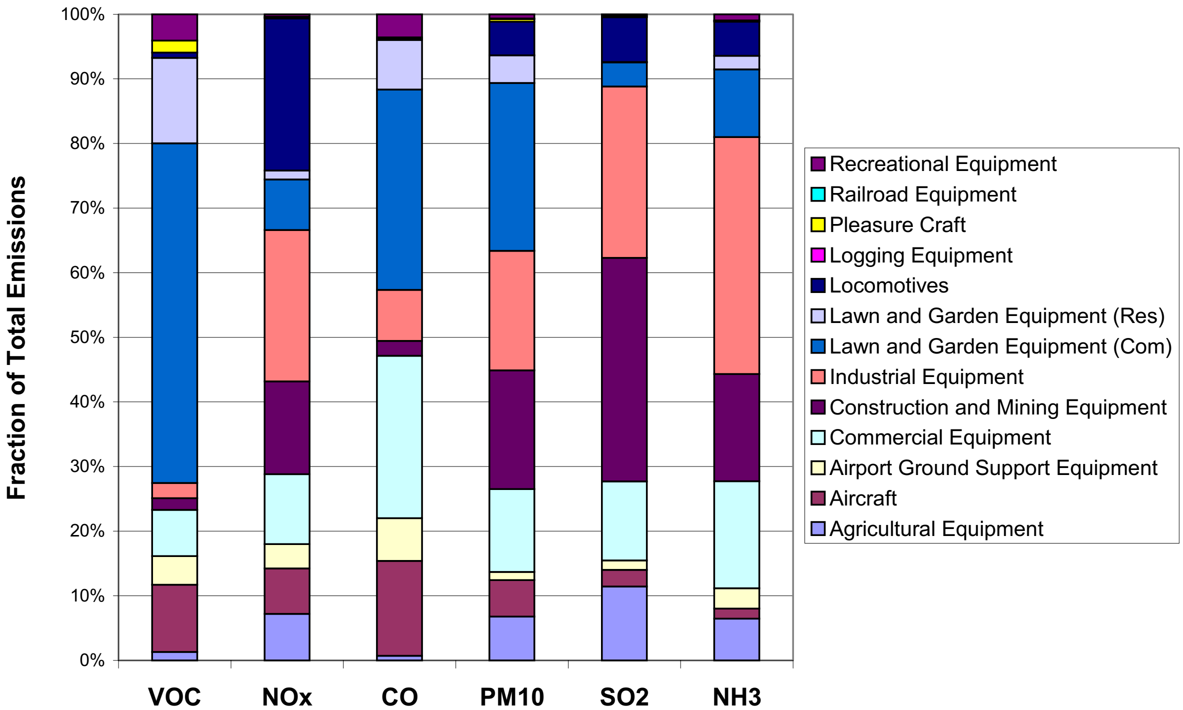

Figure 10-1. Contribution to 2015 average winter day off-road emissions by source category (Ada and Canyon counties).

10.4 DATA MANAGEMENT AND QUALITY ASSURANCE/QUALITY CONTROL

In general, procedures described in *Final Inventory Preparation Plan/Quality Assurance Plan (IPP/QAP)* (ENVIRON, 2001) were used to check, and correct when necessary, the off-road mobile sources emissions estimates. All NONROAD model input and output files, and Excel spreadsheets used to calculate the emissions, were checked by personnel who were not involved in the development of the modeling inputs/outputs and spreadsheets. Hand calculations were also performed to verify that the growth factors were applied correctly. In addition, the emissions estimates were reviewed for reasonableness by IDEQ staff and external stakeholders.

11.0 FUTURE YEAR EMISSION INVENTORY RESULTS

The previous four sections described the methods used to estimate annual and episodic emission inventories for point, area, on-road, and off-road sources for three future years – 2010, 2015, and 2020. These emission inventories were developed for direct emissions of PM_{10}, and for PM_{10} precursors – nitrogen oxides (NO_x), sulfur oxides (SO_x), volatile organic compounds (VOCs), carbon monoxide (CO), and ammonia (NH_3). In this section we provide tables and graphs that show the annual and episodic emissions for all source categories for the three future years.

11.1 ANNUAL EMISSION INVENTORIES

Annual emission inventories by source category for the three future years are shown in Tables 11-1 through 11-3; Figure 11-1 shows the relative contribution by major source category to the 2015 annual emissions. The largest change in comparison to the 1999 annual emissions (shown in Table 6-1) is for point sources. This is because the future year point source emissions are estimated at maximum *potential to emit* (PTE), calculated using maximum design capacities for each source, while the base year emissions are *actual* emissions levels. Area sources and non-road emissions increase slightly, corresponding primarily to growth factors (provided in Sections 8 and 10, respectively). On-road emissions for criteria pollutants (NO_X, VOC, and CO) decrease in future years despite VMT growth, as fleet turnover introduces more new vehicles that meet tighter emissions standards. On-road emissions for PM_{10} and SO_X though, increase, as predicted by the current (outdated) PART5 model.

11.2 EPISODIC EMISSION INVENTORIES

Episodic emission inventories were calculated using the methods described in previous sections of this report. For CAMx dispersion modeling, two adjustments were made to these episodic emission inventories. First, the voluntary burn ban was applied to generate a *controlled* emission inventory. Second, road dust emissions were adjusted to account for the seven inches of snow on the ground during the December 1991 episode.

The controlled emission inventory includes the effects of the voluntary IDEQ residential wood burning ban program. This program comprises a tiered approach, with a voluntary-based ban triggered at relatively moderate PM_{10} levels, followed by a mandatory ban triggered at higher PM10 levels. Specifically, the voluntary burn ban is called for in Ada County when the preceding day's maximum monitored 24-hour PM_{10} concentration exceeds 74 mg/m3 at any of the monitors. According to the 1991 SIP for Ada County, approved by EPA, the assumed effectiveness of the voluntary burn ban is a 43 percent reduction in residential wood smoke emissions. The mandatory burn ban is triggered at 100 mg/m3 and above, with an assumed effectiveness (from the approved 1991 SIP) of 80 percent The voluntary and mandatory bans remain in effect until the IDEQ identifies when the prevailing meteorological conditions improve to end the pollution episode.

Table 11-1. 2010 annual emission inventories, Ada and Canyon counties combined.

	PM_{10}		NOx		SOx		NH3		VOC		CO	
Source Category	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**
Industrial Point Sources	**5,279**	**8.6%**	**14,937**	**53.8%**	**7,280**	**74.3%**	**1,007**	**13.4%**	**4,754**	**12.9%**	**13,207**	**8.7%**
Area Sources	**22,582**	**36.8%**	**2,036**	**7.3%**	**125**	**1.3%**	**6,236**	**83.1%**	**25,629**	**69.4%**	**13,705**	**9.1%**
Residential Wood Combustion	643	1.0%	59	0.2%	9	0.1%	0	0.0%	2,710	7.3%	4,687	3.1%
Other Fuel Combustion	196	0.3%	1,105	4.0%	72	0.7%	9	0.1%	51	0.1%	607	0.4%
Open Burning	2,505	4.1%	311	1.1%	44	0.5%	0	0.0%	2,075	5.6%	8,412	5.6%
Agricultural Activities	15,318	25.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Other Fugitive Dust	3,920	6.4%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Ammonia sources	0	0.0%	0	0.0%	0	0.0%	6,228	83.0%	0	0.0%	0	0.0%
Biogenic Emissions	0	0.0%	561	2.0%	0	0.0%	0	0.0%	11,090	30.0%	0	0.0%
VOC Sources	0	0.0%	0	0.0%	0	0.0%	0	0.0%	9,703	26.3%	0	0.0%
On-Road Mobile Sources	**32,892**	**53.7%**	**5,703**	**20.5%**	**581**	**5.9%**	**251**	**3.3%**	**3,085**	**8.3%**	**57,188**	**37.8%**
Vehicle Emissions (Exhaust, Tire Wear, & Brake Wear)	410	0.7%	5,703	20.5%	581	5.9%	251	3.3%	3,085	8.3%	57,188	37.8%
Fugitive Road Dust	32,483	53.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Non-Road Mobile Sources	**543**	**0.9%**	**5,085**	**18.3%**	**1,813**	**18.5%**	**12**	**0.2%**	**3,484**	**9.4%**	**67,177**	**44.4%**
Aircraft	16	0.0%	189	0.7%	22	0.2%	0	0.0%	342	0.9%	6,232	4.1%
Airport Ground Support Equipment	4	0.0%	94	0.3%	12	0.1%	0	0.0%	133	0.4%	2,633	1.7%
Lawn & Garden Equipment	119	0.2%	443	1.6%	106	1.1%	2	0.0%	1,928	5.2%	36,691	24.3%
Recreational Equipment	4	0.0%	24	0.1%	3	0.0%	0	0.0%	225	0.6%	3,253	2.2%
Commercial and Industrial Equipment	110	0.2%	1,120	4.0%	367	3.7%	4	0.1%	326	0.9%	13,807	9.1%
Construction and Mining Equipment	152	0.2%	1,298	4.7%	751	7.7%	3	0.0%	176	0.5%	2,402	1.6%
Agricultural Equipment	112	0.2%	1,214	4.4%	483	4.9%	2	0.0%	166	0.4%	1,536	1.0%
Recreational Marine Vessels	8	0.0%	19	0.1%	4	0.0%	0	0.0%	160	0.4%	546	0.4%
Locomotives and Railroad Equipment	17	0.0%	684	2.5%	65	0.7%	0	0.0%	29	0.1%	78	0.1%
TOTAL	**61,297**		**27,762**		**9,799**		**7,506**		**36,952**		**151,276**	

Table 11-2. 2015 annual emission inventories, Ada and Canyon counties combined.

	PM_{10}		NOx		SOx		NH3		VOC		CO	
Source Category	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**
Industrial Point Sources	**5,279**	**8.0%**	**14,937**	**57.9%**	**7,280**	**72.6%**	**1,007**	**13.4%**	**4,754**	**12.5%**	**13,207**	**8.4%**
Area Sources	**22,988**	**34.9%**	**2,201**	**8.5%**	**139**	**1.4%**	**6,224**	**82.6%**	**27,100**	**71.3%**	**14,882**	**9.4%**
Residential Wood Combustion	717	1.1%	66	0.3%	10	0.1%	0	0.0%	3,028	8.0%	5,225	3.3%
Other Fuel Combustion	218	0.3%	1,229	4.8%	79	0.8%	10	0.1%	57	0.2%	672	0.4%
Open Burning	2,757	4.2%	345	1.3%	50	0.5%	0	0.0%	2,271	6.0%	8,984	5.7%
Agricultural Activities	15,104	22.9%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Other Fugitive Dust	4,192	6.4%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Ammonia sources	0	0.0%	0	0.0%	0	0.0%	6,215	82.5%	0	0.0%	0	0.0%
Biogenic Emissions	0	0.0%	561	2.2%	0	0.0%	0	0.0%	11,090	29.2%	0	0.0%
VOC Sources	0	0.0%	0	0.0%	0	0.0%	0	0.0%	10,654	28.0%	0	0.0%
On-Road Mobile Sources	**36,996**	**56.2%**	**3,957**	**15.3%**	**675**	**6.7%**	**289**	**3.8%**	**2,547**	**6.7%**	**55,640**	**35.3%**
Vehicle Emissions (Exhaust, Tire Wear, & Brake Wear)	462	0.7%	3,957	15.3%	675	6.7%	289	3.8%	2,547	6.7%	55,640	35.3%
Fugitive Road Dust	36,533	55.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Non-Road Mobile Sources	**560**	**0.9%**	**4,686**	**18.2%**	**1,940**	**19.3%**	**13**	**0.2%**	**3,623**	**9.5%**	**74,095**	**46.9%**
Aircraft	18	0.0%	204	0.8%	24	0.2%	0	0.0%	351	0.9%	6,331	4.0%
Airport Ground Support Equipment	4	0.0%	98	0.4%	13	0.1%	0	0.0%	145	0.4%	2,888	1.8%
Lawn & Garden Equipment	132	0.2%	468	1.8%	119	1.2%	2	0.0%	2,079	5.5%	41,221	26.1%
Recreational Equipment	5	0.0%	25	0.1%	4	0.0%	0	0.0%	251	0.7%	3,644	2.3%
Commercial and Industrial Equipment	116	0.2%	1,131	4.4%	407	4.1%	5	0.1%	331	0.9%	15,202	9.6%
Construction and Mining Equipment	158	0.2%	1,096	4.3%	827	8.2%	3	0.0%	154	0.4%	2,636	1.7%
Agricultural Equipment	102	0.2%	958	3.7%	478	4.8%	2	0.0%	136	0.4%	1,507	1.0%
Recreational Marine Vessels	8	0.0%	22	0.1%	4	0.0%	0	0.0%	147	0.4%	588	0.4%
Locomotives and Railroad Equipment	17	0.0%	683	2.6%	65	0.6%	0	0.0%	29	0.1%	78	0.0%
TOTAL	**65,822**		**25,781**		**10,033**		**7,534**		**38,024**		**157,822**	

Table 11-3. 2020 annual emission inventories, Ada and Canyon counties combined.

	PM_{10}		NOx		SOx		NH3		VOC		CO	
Source Category	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**	**tons/year**	**% of total**
Industrial Point Sources	**5,279**	**7.6%**	**14,937**	**59.7%**	**7,280**	**71.0%**	**1,007**	**13.3%**	**4,754**	**12.2%**	**13,207**	**8.1%**
Area Sources	**22,992**	**32.9%**	**2,303**	**9.2%**	**145**	**1.4%**	**6,212**	**82.1%**	**28,065**	**72.3%**	**15,316**	**9.4%**
Residential Wood Combustion	744	1.1%	68	0.3%	10	0.1%	0	0.0%	3,134	8.1%	5,419	3.3%
Other Fuel Combustion	228	0.3%	1,315	5.3%	83	0.8%	10	0.1%	61	0.2%	716	0.4%
Open Burning	2,849	4.1%	358	1.4%	52	0.5%	0	0.0%	2,343	6.0%	9,181	5.6%
Agricultural Activities	14,889	21.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Other Fugitive Dust	4,282	6.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Ammonia sources	0	0.0%	0	0.0%	0	0.0%	6,202	82.0%	0	0.0%	0	0.0%
Biogenic Emissions	0	0.0%	561	2.2%	0	0.0%	0	0.0%	11,090	28.6%	0	0.0%
VOC Sources	0	0.0%	0	0.0%	0	0.0%	0	0.0%	11,437	29.4%	0	0.0%
On-Road Mobile Sources	**41,044**	**58.7%**	**3,144**	**12.6%**	**779**	**7.6%**	**332**	**4.4%**	**2,321**	**6.0%**	**56,953**	**35.0%**
Vehicle Emissions (Exhaust, Tire Wear, & Brake Wear)	531	0.8%	3,144	12.6%	779	7.6%	332	4.4%	2,321	6.0%	56,953	35.0%
Fugitive Road Dust	40,514	58.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Non-Road Mobile Sources	**580**	**0.8%**	**4,630**	**18.5%**	**2,053**	**20.0%**	**14**	**0.2%**	**3,702**	**9.5%**	**77,326**	**47.5%**
Aircraft	20	0.0%	220	0.9%	25	0.2%	0	0.0%	362	0.9%	6,448	4.0%
Airport Ground Support Equipment	4	0.0%	104	0.4%	14	0.1%	0	0.0%	157	0.4%	3,136	1.9%
Lawn & Garden Equipment	135	0.2%	468	1.9%	122	1.2%	2	0.0%	2,127	5.5%	42,362	26.0%
Recreational Equipment	5	0.0%	25	0.1%	4	0.0%	0	0.0%	258	0.7%	3,760	2.3%
Commercial and Industrial Equipment	124	0.2%	1,187	4.7%	444	4.3%	5	0.1%	350	0.9%	16,565	10.2%
Construction and Mining Equipment	169	0.2%	1,103	4.4%	902	8.8%	4	0.0%	158	0.4%	2,876	1.8%
Agricultural Equipment	97	0.1%	815	3.3%	472	4.6%	2	0.0%	121	0.3%	1,487	0.9%
Recreational Marine Vessels	8	0.0%	23	0.1%	4	0.0%	0	0.0%	140	0.4%	615	0.4%
Locomotives and Railroad Equipment	17	0.0%	685	2.7%	65	0.6%	0	0.0%	29	0.1%	78	0.0%
TOTAL	**69,895**		**25,014**		**10,257**		**7,565**		**38,841**		**162,802**	

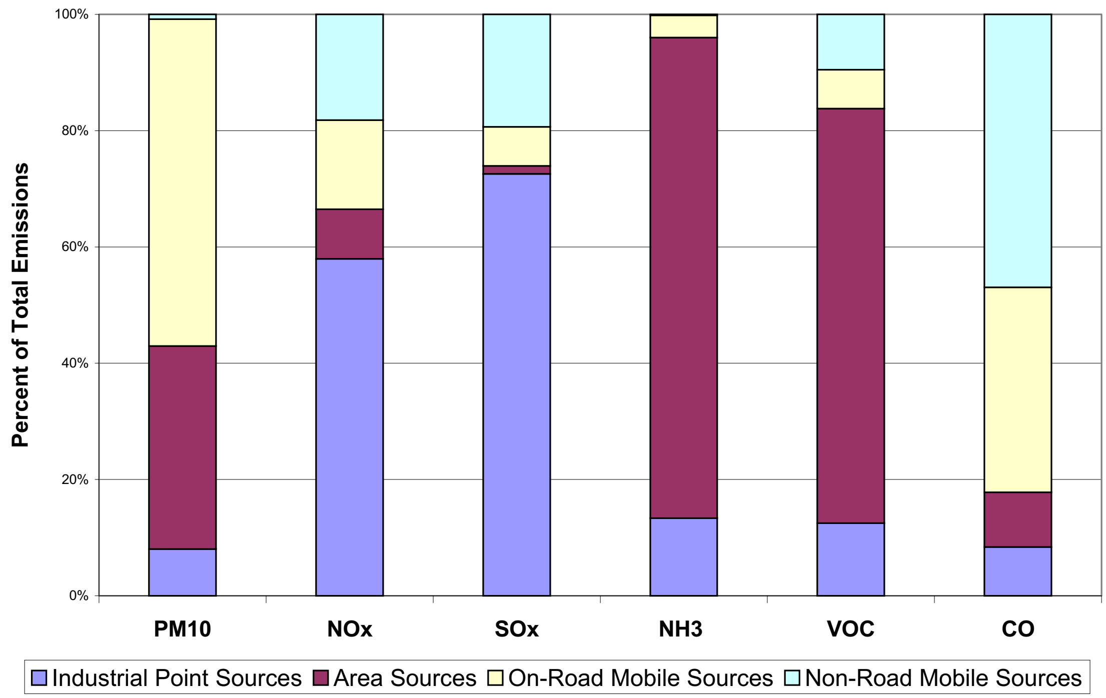

Figure 11-1. Contribution to 2015 annual emissions by major source category (Ada and Canyon counties).

The future year episodic emission inventories include an adjustment to fugitive road dust emissions. To account for the mitigating effects of snow cover when modeling with January 1991 meteorology, the full paved road dust emission rates were scaled down by a factor of 2.4, and unpaved road dust emissions were completely removed (Etyemezian et al., 2001). (The CAMx dispersion modeling was also run for the December 20-24, 1999 meteorological period with the future year episodic emission inventories, except in that case the full road dust rates were included due to lack of snow.)

The factor of 2.4 was calculated using the following approach. Receptor modeling carried out in this study shows that road dust comprised 9.9 of 163 ug/m3 in 1991, and 31.2 of 69.5 ug/m3 in 1999 (see the supplementary Receptor Modeling report). It is assumed that the difference between 1991 and 1999 is related to the presence of snow and growth in vehicle miles traveled (VMT) in the valley. The ratio of 1999 to 1991 road dust is 3.15. However, it is necessary for the factor to account for the increase in VMT from 1991 to 1999. VMT for 1991 can be estimated by fitting an exponential function to year 2000 and the three predicted future year VMT levels (Etyemezian et al., 2001):

$$VMT = 2.20E\text{-}19\exp(2.95E\text{-}02\ year)$$

According to this equation, the estimated 1991 VMT is 6.77MM miles, while 2000 VMT is 8.79MM miles; this results in a growth rate of 30 perent in that period. The final adjustment factor for each of the future years is thus 3.15/1.30 = 2.4.

The resulting episodic emission inventories corresponding to the meteorology on the highest observed concentration day in the 1991 episode (January 7) are shown in Tables 11-4 through 11-6 for years 2010, 2015, and 2020, respectively; Figure 11-2 shows the relative contribution by major source category for the 2015 episode. The corresponding information for the 1999 episodic emission inventory may be found in Table 6-2 and Figure 6-2.

Note that there are four factors that result in large differences between the base and future year episodic emission inventories:

- Episodic point source emissions are PTE levels in the future years and actual emissions in the base year.
- December 24 in the base year is modeled as a weekend day, while January 7 in the future years is modeled as a weekday. For most emission sources, weekday activity levels and thus emissions are higher on weekdays than on weekends.
- The voluntary burn ban in Ada County was imposed; this ban results in significant reduction in emissions from residential wood combustion.
- Road dust emissions were reduced to account for snow cover on the ground.

In the future year episodic emission inventories, fugitive road dust is still the dominant source of PM_{10} emissions, with most of the remainder attributed to point sources. NO_x emissions are largely from point sources at their PTE levels, with on-road and off-road mobile sources also contributing significantly. SO_X emissions in the future year episodic inventories are completely dominated by point sources. The distribution of VOC and CO emissions are similar to the 1999 episode inventories.

Table 11-4. 2010 episode emission inventories, Ada and Canyon Counties combined. Emissions are for the highest observed concentration day in the 1991 episode, January 7.

	PM10		NOx		SOx		NH3		VOC		CO	
Source Category	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**
Industrial Point Sources	**12.20**	**23.9%**	**44.83**	**57.1%**	**23.92**	**84.2%**	**2.77**	**15.4%**	**15.07**	**22.6%**	**38.77**	**9.1%**
Area Sources	**3.37**	**6.6%**	**5.61**	**7.1%**	**0.41**	**1.4%**	**14.49**	**80.6%**	**33.60**	**50.4%**	**22.47**	**5.3%**
Residential Wood Combustion	2.67	5.2%	0.26	0.3%	0.04	0.1%	0.00	0.0%	9.22	13.8%	19.51	4.6%
Other Fuel Combustion	0.68	1.3%	4.67	5.9%	0.37	1.3%	0.04	0.2%	0.24	0.4%	2.90	0.7%
Open Burning	0.02	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.01	0.0%	0.06	0.0%
Agricultural Activities	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Other Fugitive Dust	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Ammonia sources	0.00	0.0%	0.00	0.0%	0.00	0.0%	14.45	80.4%	0.00	0.0%	0.00	0.0%
Biogenic Emissions	0.00	0.0%	0.67	0.9%	0.00	0.0%	0.00	0.0%	2.87	4.3%	0.00	0.0%
VOC Sources	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	21.26	31.9%	0.00	0.0%
On-Road Mobile Sources	**34.66**	**67.8%**	**19.13**	**24.4%**	**1.55**	**5.5%**	**0.70**	**3.9%**	**9.59**	**14.4%**	**254.91**	**59.8%**
Vehicle Emissions (Exhaust, Tire Wear, & Brake Wear)	0.46	0.9%	19.13	24.4%	1.55	5.5%	0.70	3.9%	9.59	14.4%	254.91	59.8%
Fugitive Road Dust	34.19	66.9%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Non-Road Mobile Sources	**0.90**	**1.8%**	**8.98**	**11.4%**	**2.51**	**8.8%**	**0.02**	**0.1%**	**8.35**	**12.5%**	**110.39**	**25.9%**
Aircraft	0.04	0.1%	0.52	0.7%	0.06	0.2%	0.00	0.0%	0.94	1.4%	17.07	4.0%
Airport Ground Support Equipment	0.01	0.0%	0.32	0.4%	0.03	0.1%	0.00	0.0%	0.36	0.5%	6.72	1.6%
Lawn & Garden Equipment	0.25	0.5%	0.80	1.0%	0.09	0.3%	0.00	0.0%	5.49	8.2%	40.83	9.6%
Recreational Equipment	0.00	0.0%	0.03	0.0%	0.00	0.0%	0.00	0.0%	0.19	0.3%	2.64	0.6%
Commercial and Industrial Equipment	0.29	0.6%	3.07	3.9%	0.93	3.3%	0.01	0.1%	0.95	1.4%	39.11	9.2%
Construction and Mining Equipment	0.18	0.4%	1.54	2.0%	0.89	3.1%	0.00	0.0%	0.21	0.3%	2.73	0.6%
Agricultural Equipment	0.08	0.1%	0.83	1.1%	0.33	1.1%	0.00	0.0%	0.11	0.2%	0.98	0.2%
Recreational Marine Vessels	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.04	0.1%	0.09	0.0%
Locomotives and Railroad Equipment	0.05	0.1%	1.88	2.4%	0.18	0.6%	0.00	0.0%	0.08	0.1%	0.22	0.1%
TOTAL	**51.13**		**78.54**		**28.39**		**17.98**		**66.61**		**426.54**	

Table 11-5. 2015 episode emission inventories, Ada and Canyon Counties combined. Emissions are for the highest observed concentration day in the 1991 episode, January 7.

	PM10		NOx		SOx		NH3		VOC		CO	
Source Category	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**
Industrial Point Sources	**12.20**	**21.7%**	**44.83**	**61.8%**	**23.92**	**82.9%**	**2.77**	**15.3%**	**15.07**	**22.1%**	**38.77**	**9.0%**
Area Sources	**3.74**	**6.7%**	**6.16**	**8.5%**	**0.45**	**1.6%**	**14.49**	**80.1%**	**36.84**	**54.0%**	**24.92**	**5.8%**
Residential Wood Combustion	2.96	5.3%	0.29	0.4%	0.04	0.1%	0.00	0.0%	10.25	15.0%	21.63	5.0%
Other Fuel Combustion	0.76	1.3%	5.19	7.2%	0.41	1.4%	0.04	0.2%	0.26	0.4%	3.21	0.7%
Open Burning	0.02	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.01	0.0%	0.07	0.0%
Agricultural Activities	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Other Fugitive Dust	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Ammonia sources	0.00	0.0%	0.00	0.0%	0.00	0.0%	14.45	79.9%	0.00	0.0%	0.00	0.0%
Biogenic Emissions	0.00	0.0%	0.67	0.9%	0.00	0.0%	0.00	0.0%	2.87	4.2%	0.00	0.0%
VOC Sources	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	23.44	34.4%	0.00	0.0%
On-Road Mobile Sources	**39.28**	**69.9%**	**12.89**	**17.8%**	**1.78**	**6.2%**	**0.81**	**4.4%**	**7.28**	**10.7%**	**248.54**	**57.4%**
Vehicle Emissions (Exhaust, Tire Wear, & Brake Wear)	0.49	0.9%	12.89	17.8%	1.78	6.2%	0.81	4.4%	7.28	10.7%	248.54	57.4%
Fugitive Road Dust	38.79	69.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Non-Road Mobile Sources	**0.95**	**1.7%**	**8.71**	**12.0%**	**2.72**	**9.4%**	**0.02**	**0.1%**	**9.03**	**13.2%**	**120.92**	**27.9%**
Aircraft	0.05	0.1%	0.56	0.8%	0.06	0.2%	0.00	0.0%	0.96	1.4%	17.35	4.0%
Airport Ground Support Equipment	0.01	0.0%	0.33	0.5%	0.03	0.1%	0.00	0.0%	0.39	0.6%	7.38	1.7%
Lawn & Garden Equipment	0.28	0.5%	0.86	1.2%	0.10	0.4%	0.00	0.0%	6.12	9.0%	45.90	10.6%
Recreational Equipment	0.00	0.0%	0.03	0.0%	0.00	0.0%	0.00	0.0%	0.21	0.3%	2.95	0.7%
Commercial and Industrial Equipment	0.30	0.5%	3.10	4.3%	1.04	3.6%	0.01	0.1%	0.96	1.4%	43.07	9.9%
Construction and Mining Equipment	0.19	0.3%	1.30	1.8%	0.97	3.4%	0.00	0.0%	0.18	0.3%	2.99	0.7%
Agricultural Equipment	0.07	0.1%	0.65	0.9%	0.32	1.1%	0.00	0.0%	0.09	0.1%	0.96	0.2%
Recreational Marine Vessels	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.04	0.1%	0.10	0.0%
Locomotives and Railroad Equipment	0.05	0.1%	1.87	2.6%	0.18	0.6%	0.00	0.0%	0.08	0.1%	0.22	0.1%
TOTAL	**56.18**		**72.59**		**28.87**		**18.09**		**68.22**		**433.15**	

Table 11-6. 2020 episode emission inventories, Ada and Canyon Counties combined. Emissions are for the highest observed concentration day in the 1991 episode, January 7.

	PM10		NOx		SOx		NH3		VOC		CO	
Source Category	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**	**tons/day**	**% of total**
Industrial Point Sources	**12.20**	**20.1%**	**44.83**	**64.0%**	**23.92**	**81.5%**	**2.77**	**15.2%**	**15.07**	**21.5%**	**38.77**	**8.7%**
Area Sources	**3.90**	**6.4%**	**6.52**	**9.3%**	**0.47**	**1.6%**	**14.50**	**79.6%**	**39.28**	**56.0%**	**26.04**	**5.9%**
Residential Wood Combustion	3.09	5.1%	0.30	0.4%	0.04	0.2%	0.00	0.0%	10.66	15.2%	22.55	5.1%
Other Fuel Combustion	0.79	1.3%	5.54	7.9%	0.43	1.5%	0.04	0.2%	0.28	0.4%	3.41	0.8%
Open Burning	0.03	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.02	0.0%	0.07	0.0%
Agricultural Activities	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Other Fugitive Dust	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Ammonia sources	0.00	0.0%	0.00	0.0%	0.00	0.0%	14.45	79.4%	0.00	0.0%	0.00	0.0%
Biogenic Emissions	0.00	0.0%	0.67	1.0%	0.00	0.0%	0.00	0.0%	2.87	4.1%	0.00	0.0%
VOC Sources	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	25.45	36.3%	0.00	0.0%
On-Road Mobile Sources	**43.56**	**71.8%**	**9.82**	**14.0%**	**2.04**	**7.0%**	**0.92**	**5.1%**	**6.52**	**9.3%**	**252.70**	**56.8%**
Vehicle Emissions (Exhaust, Tire Wear, & Brake Wear)	0.55	0.9%	9.82	14.0%	2.04	7.0%	0.92	5.1%	6.52	9.3%	252.70	56.8%
Fugitive Road Dust	43.01	70.9%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Non-Road Mobile Sources	**1.00**	**1.6%**	**8.85**	**12.6%**	**2.91**	**9.9%**	**0.02**	**0.1%**	**9.31**	**13.3%**	**127.49**	**28.6%**
Aircraft	0.06	0.1%	0.60	0.9%	0.07	0.2%	0.00	0.0%	0.99	1.4%	17.62	4.0%
Airport Ground Support Equipment	0.01	0.0%	0.36	0.5%	0.04	0.1%	0.00	0.0%	0.42	0.6%	8.03	1.8%
Lawn & Garden Equipment	0.29	0.5%	0.87	1.2%	0.10	0.4%	0.00	0.0%	6.28	9.0%	47.20	10.6%
Recreational Equipment	0.00	0.0%	0.03	0.0%	0.00	0.0%	0.00	0.0%	0.22	0.3%	3.05	0.7%
Commercial and Industrial Equipment	0.32	0.5%	3.25	4.6%	1.14	3.9%	0.01	0.1%	1.02	1.4%	47.05	10.6%
Construction and Mining Equipment	0.20	0.3%	1.31	1.9%	1.06	3.6%	0.00	0.0%	0.19	0.3%	3.27	0.7%
Agricultural Equipment	0.07	0.1%	0.56	0.8%	0.32	1.1%	0.00	0.0%	0.08	0.1%	0.95	0.2%
Recreational Marine Vessels	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.04	0.1%	0.11	0.0%
Locomotives and Railroad Equipment	0.05	0.1%	1.87	2.7%	0.18	0.6%	0.00	0.0%	0.08	0.1%	0.22	0.0%
TOTAL	**60.66**		**70.02**		**29.34**		**18.21**		**70.18**		**445.00**	

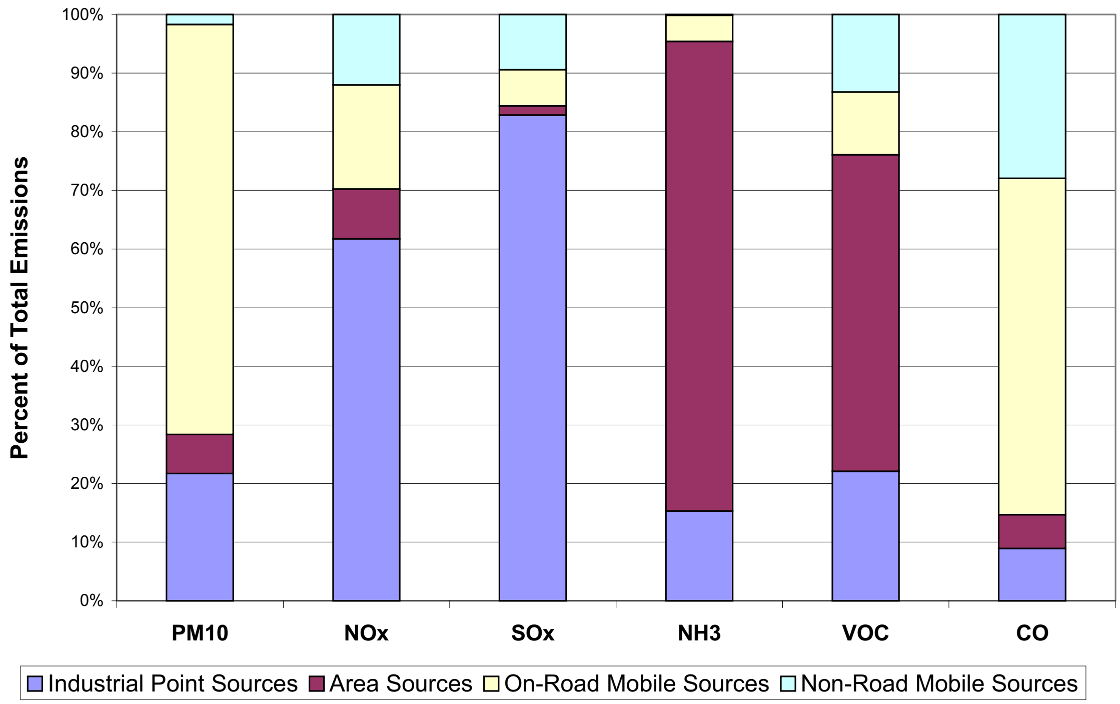

Figure 11-2. Contribution to 2015 episodic emissions by major source category (Ada and Canyon counties, 7 January 1991 meteorology).

12.0 EMISSION INVENTORY PROCESSING FOR DISPERSION MODELING

Previous sections of this report have described how the emission inventory estimates for Ada and Canyon counties for the base and future years were derived. In this section we describe how the emissions were processed into model-ready files for use in the CAMx dispersion modeling. Figure 12-1 shows the modeling domain, which includes not just Ada and Canyon counties but also portions of Boise, Owyhee, Gem, and Payette counties in Idaho, and Malheur County in Oregon. In this section, the development of emissions for these surrounding counties is described. The second portion of this section describes the gridding surrogates that were used to spatially resolve the county-level emissions to the 1km x 1km grid cells required for CAMx dispersion modeling.

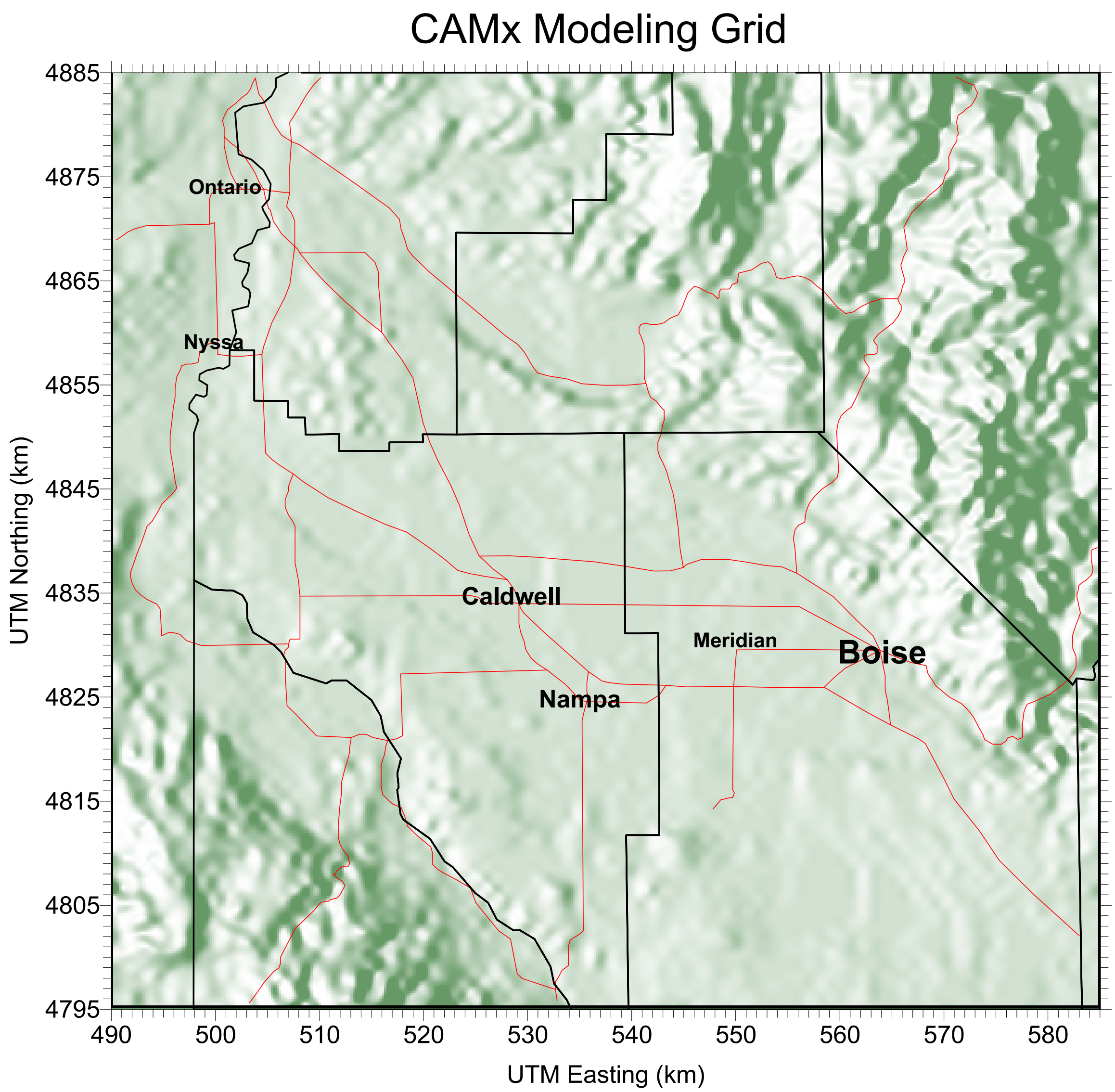

Figure 12-1. Modeling domain for CAMx dispersion modeling. Tick marks on the axes represent the size of 1-km grid cells. Black lines denote county boundaries and red lines show major highways. Overall domain size is 95 by 90 km.

12.1 DEVELOPMENT OF EMISSIONS FOR OUTLYING COUNTIES

The CAMx modeling domain was expanded from earlier dispersion modeling of the Treasure Valley with WYNDValley. This expansion resulted in the inclusion of several surrounding counties, primarily to the north and west. While considered to be mainly rural counties, they do contain the I-84 corridor to the northwest, along with some additional large industrial facilities and small towns. The PM and precursors from these sources likely drain into the valley during episodic conditions, adding an increment above background levels. It was considered to be a better approach to include their relatively small emissions contributions to overall PM throughout the valley. Otherwise, had the smaller modeling domain from earlier modeling been used, it would have been necessary to quantify the impacts of these outside counties via boundary conditions, which could only have been guessed since no measurement data were available in that area.

The additional Idaho counties needing emission estimates included Owyhee, Payette, Gem, and Boise. Payette and Gem Counties include some of the I-84 corridor, and as part of the Snake River Plain, contain agricultural activities. Owyhee and Boise counties possess the high terrain to the southwest and northeast of the plain, respectively, and therefore contain higher biogenic emissions. The small portion of Malheur County, Oregon, in the northwest corner of the modeling domain contains the towns of Nyssa and Ontario. Some industrial facilities also exist in this area, and it was easier to include them in the domain rather than attempting to estimate their influence on boundary conditions if the domain contained only Idaho counties.

12.1.1 Base Year Inventory

Relative to Ada and Canyon Counties, anthropogenic emissions in the surrounding rural counties are low. Therefore, the approach to include these counties was to use existing emission databases provided by EPA's 1999 National Emission Trends (NET) inventory.

The NET99 inventory, Version 1 for Criteria Pollutants, was released by EPA on 20 March 2001. The data files were acquired from EPA's ftp site (ftp.epa.gov). The file format documentation was provided at http://www.epa.gov/ttn/chief/eidocs/index.html#pack. The NET99 inventory contains county-level, annual emission estimates, and is stratified into three major components: area sources (including non-road motor vehicle), on-road motor vehicle sources, and point sources. NET99 biogenic emissions were replaced with emission estimates from PC-BEIS for the modeling domain, as described in Section 3.2.8.

The steps required to process the NET99 inventory into a model-ready inventory include chemical speciation, temporal distribution, and spatial allocation. All of these steps are performed using gridding surrogates and speciation/temporal allocation profiles assigned to each individual source category listed within each of the three component files. This processing was accomplished using the EPS2x system developed at ENVIRON, and was performed in tandem with the Ada and Canyon inventories. The EPS2x system is an extension of the Emissions Preprocessor System 2.0 (EPS2) and distributed by the EPA. The main extensions and features added by ENVIRON to create EPS2x consist of algorithms to decrease processing time and increase efficiency of input data.

12.1.1.1 Area Sources

As previously stated, the area source inventory from NET99 also contained the non-road motor vehicle sources. The annual NET99 inventory was adjusted to create three episodic daily inventories: typical December weekday, typical December Saturday, and typical December Sunday. Default EPS2 profile and surrogate libraries were used in the processing of area sources with the exceptions of (1) the particulate speciation for all sources, and (2) the temporal allocation of residential wood combustion. Since EPS2 contains no default chemical speciation profiles for particulate species, they were extracted from a special dataset used to process emissions for the REMSAD modeling performed by the EPA. As with the Ada and Canyon county inventories, updated diurnal profiles were used to allocate the daily emissions estimates to each hour of the day for residential wood combustion. The county-level data were allocated to the modeling grid using the county area and gridded land use surrogate files described in later in this section. Table 12-1 shows the model-ready area and non-road motor vehicle emission totals by county.

Table 12-1. NET99 area and non-road source emissions totals (tons/day) for outlying counties.

County	NOx	VOC	CO	SOx	NH3	PM
Weekday						
Boise, ID	0.0329	0.3899	1.9600	0.0083	0.3325	2.2077
Gem., ID	0.6251	2.0050	6.2066	0.1923	2.3772	11.3542
Owyhee, ID	0.2001	0.7175	1.6104	0.0804	2.8126	2.4910
Payette, ID	1.2653	2.3731	6.6151	0.3391	3.0632	20.4396
Malheur, OR	0.7702	2.3377	6.3651	0.3856	3.7897	5.2207
Saturday						
Boise, ID	0.0329	0.3670	1.9085	0.0086	0.3325	2.1978
Gem, ID	0.5707	1.3696	6.0609	0.1593	2.3768	11.2696
Owyhee, ID	0.1888	0.5056	1.5827	0.0727	2.8126	2.4757
Payette, ID	1.0672	1.5714	6.5294	0.2732	3.0622	20.3014
Malheur, OR	0.7254	1.6279	6.3489	0.2999	3.7894	5.1881
Sunday						
Boise, ID	0.0321	0.3599	1.8473	0.0084	0.3325	2.1885
Gem, ID	0.5137	1.2134	5.9302	0.1250	2.3765	11.2063
Owyhee, ID	0.1762	0.4612	1.5644	0.0648	2.8125	2.4591
Payette, ID	0.8665	1.3791	6.2326	0.2057	3.0612	20.2058
Malheur, OR	0.6766	1.5716	6.2921	0.2132	3.7890	5.1557

12.1.1.2 On-Road Motor Vehicle Sources

In the NET99 database, the on-road motor vehicle emission estimates are specified by vehicle class and roadway type. In processing the NET99 inventory using EPS2x, the only non-default input data used was the particulate speciation data. In this step, the EPA REMSAD speciation profiles were used and a simple vehicle split by type was assumed (gasoline vs. diesel). The temporal distribution and spatial allocation was based on roadway type (for example, Urban Highways). Table 12-2 shows the model-ready on-road mobile emission totals by county.

Table 12-2. NET99 on-road motor vehicle source emissions totals (tons/day) for outlying counties.

County	NOx	VOC	CO	SOx	NH3	PM
Weekday						
Boise, ID	0.2781	0.1000	0.9406	0.0104	0.0761	0.0113
Gem. ID	0.8155	0.4248	4.1330	0.0336	0.2999	0.0332
Owyhee, ID	0.6065	0.0793	0.7202	0.0208	0.0465	0.0299
Payette, ID	3.3506	1.6620	16.7384	0.1229	1.2484	0.1113
Malheur, OR	2.5866	0.7529	7.7133	0.0863	0.4593	0.1069
Saturday						
Boise, ID	0.2086	0.0749	0.7047	0.0078	0.0572	0.0085
Gem, ID	0.6111	0.3183	3.0982	0.0252	0.2250	0.0249
Owyhee, ID	0.4549	0.0595	0.5399	0.0156	0.0348	0.0224
Payette, ID	2.5121	1.2472	12.5434	0.0922	0.9366	0.0834
Malheur, OR	1.9399	0.5654	5.7807	0.0647	0.3442	0.0802
Sunday						
Boise, ID	0.2086	0.0749	0.7047	0.0078	0.0572	0.0085
Gem, ID	0.6111	0.3183	3.0982	0.0252	0.2250	0.0249
Owyhee, ID	0.4549	0.0595	0.5399	0.0156	0.0348	0.0224
Payette, ID	2.5121	1.2472	12.5434	0.0922	0.9366	0.0834
Malheur, OR	1.9399	0.5654	5.7807	0.0647	0.3442	0.0802

12.1.1.3 Major Point Sources

The processing of the NET99 point source component of the base inventory was a fairly standard application of EPS2x. EPS2 default files were used for all allocation/profile libraries with the exception of the particulate speciation data. Again, the speciation profiles for PM, which are based on the 8-digit Source Category Code (SCC), were taken from the EPA's REMSAD modeling effort. Also, since updated emission estimates were provided by the Amalgamated Sugar Company for their Nyssa plant, the data records for this facility were removed from the NET99 inventory prior to processing through EPS2x to avoid double-counting. Malheur, OR, was the only county with facilities categorized as major point sources and contained within the modeling domain. Table 12-3 shows the major point source emissions totals by county.

Table 12-3. Major point source emissions totals (tons/day) for outlying counties.

County	NOx	VOC	CO	SOx	NH3	PM
Weekday						
Malheur, OR	0.0016	0.0117	0.0003	0.0061	0.0000	0.1109
Saturday						
Malheur, OR	0.0016	0.0117	0.0003	0.0061	0.0000	0.1109
Sunday						
Malheur, OR	0.0016	0.0117	0.0003	0.0061	0.0000	0.1109

12.1.2. Future Year Inventories

The future year emission inventories were developed from the base year inventory by applying source category specific growth factors. For the area and non-road motor vehicle sources, the growth factors were taken from the projection factors used to calculate the future year inventories for Ada and Canyon counties. For on-road motor vehicle sources, growth factors were calculated by taking the ratio of the EXPLORA estimated future year emissions to the EXPLORA estimated base year emissions in Ada and Canyon counties.

For all point sources in the NET99 database, the future year projections were calculated as follows:

- calculate the average daily 1999 episodic emissions for all Ada/Canyon points except Amalgamated Sugar Co. at Nampa (Canyon);
- calculate the future year average daily PTE for all Ada/Canyon points except Amalgamated Sugar Co. at Nampa (Canyon);
- ratio these two numbers

A projection factor was calculated in this way for each pollutant and applied to the base inventory. For the Amalgamated Nyssa plant, the scaling factor was developed from 1999 episodic emissions and future year average daily PTE for the AmalgamatedNampa facility.

12.2 Emission Inventory Gridding

For air quality modeling, the emission inventories were gridded on the 1-km by 1-km modeling domain shown in Figure 12-1. The EPS2x emissions modeling was used to perform the required processing steps to allocate the county-level area and non-road emission estimates to the modeling grid. This processing was not required for point sources, which are assigned to the grid cells where they are located, or on-road mobile sources, which were gridded using the EXPLORA model as described in Section 4.

To perform the gridding, appropriate spatial surrogates were developed for each emission source category and pollutant. Spatial surrogates are typically based on the proportion of a known region-wide characteristic variable which exists within the modeling domain grid cells (e.g. land use characteristics, population, socioeconomic data, etc.). There are numerous sources of Land Use/Land Cover (LULC) databases for use in developing surrogates. Traditionally, the USGS 1:100,000 and 1:250,00 (~200 meter resolution) LULC data have been used in emissions processing for air quality modeling. However, these data are more than a decade old and the resolution is fairly low in comparison to more recent available data. In particular, the USGS National Land Cover Data (NLCD) developed by the Multi-Resolution Land Characterization (MRLC) Consortium, a partnership of federal agencies, has developed a consistent land cover data layer for the entire conterminous U.S. based on 30-meter Landsat thematic mapper (TM) data. This data set includes the relevant land classifications needed for development of spatial surrogates.

Land use data were obtained from the USGS EROS Data Center web site (http://edcwww.cr.usgs.gov/pub/edcuser/vogel/states). This dataset provides dominant land use data for each state at a spatial resolution of 30 meters. The data files for the state of Idaho were downloaded from the site in September 2001. Table 12-4 presents the 21 land use categories and codes utilized in the NLCD datasets; more detailed descriptions of the NLCD land use types are available from the USGS web site. These eight-bit binary files were imported as a gridded image into ArcInfo, projected to the coordinate system of the modeling grid and resampled at a horizontal resolution of 450 meters. The resampling to a lower resolution was necessary due to inherent limitations in the ArcInfo GIS software. The data were then processed in Arc/Info to create polygon coverages. These coverages were then intersected first with state and county boundary files and then with the appropriate modeling grid coverage. The resulting coverages contain attributes specifying the fractional land area of each land use type within each county and modeling grid cell. These data were then exported for use as gridding surrogates in the emissions modeling with EPS2. After export, the land use codes were assigned to those recognized by EPS2 as shown in Table 12-5.

The population distribution was based on the 1990 Census of Population and Housing and is used only for spatially allocating emission source categories for which population serves as a surrogate. Emission magnitudes for these source categories are estimated based on current 2000 U.S. Census population data.

Table 12-6 presents the relationships between the spatial gridding surrogates and the corresponding emission source categories to which they are applied. Multiple category codes are summed to represent the total area of the particular land use type.

Table 12-4. Land use categories and codes utilized in the NLCD.

NLCD Category Code	NLCD Category Description	In-House Category Code
11	Open Water	1
12	Perennial Ice/Snow	2
21	Low Intensity Residential	3
22	High Intensity Residential	4
23	Commercial/Industrial/Transportation	5
31	Bare Rock/Sand/Clay	6
32	Quarries/Strip Mines/Gravel Pits	7
33	Transitional	8
41	Deciduous Forest	9
42	Evergreen Forest	10
43	Mixed Forest	11
51	Shrubland	12
61	Orchards/Vineyards/Other	13
71	Grasslands/Herbaceous	14
81	Pasture/Hay	15
82	Row Crops	16
83	Small Grains	17
84	Fallow	18
85	Urban/Recreational Grasses	19
91	Woody Wetlands	20
92	Emergent Herbaceous Wetlands	21

Table 12-5. Land use descriptions and codes recognized by EPS2 and internal codes mapped to those categories.

EPS2 Land Use Description (and code)	In-House Category Codes Mapped to EPS2 Category
County Area (1)	1-21
Residential (3)	3, 4
Urban (4)	3, 4, 5, 19
Agriculture (5)	13, 15, 16, 17
Range (6)	12, 14, 15, 16, 17, 18
Deciduous Forest (7)	9
Coniferous Forest (8)	10
Mixed Forest (9)	11
Water (10)	1, 2
Barren (11)	6, 7, 8
Nonforested Wetlands (12)	20, 21
Mixed Agriculture (13)	12, 13, 14, 15, 16, 17, 18
Urban/Recreational Grasses (14)	19
Rural (15)	1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

Table 12-6. Spatial gridding surrogate and emission source category correspondence.

Spatial Surrogate	SCC	Source Category Description
Urban	2102004000	Stationary Source Fuel Combustion, Industrial, Distillate Oil, Total: Boilers and IC Engines
Urban	2102005000	Stationary Source Fuel Combustion, Industrial, Residual Oil, Total: All Boiler Types
Urban	2102006000	Stationary Source Fuel Combustion, Industrial, Natural Gas, Total: Boilers and IC Engines
Urban	2102007000	Stationary Source Fuel Combustion, Industrial, Liquified Petroleum Gas (LPG), Total: All Boiler Types
Urban	2103004000	Stationary Source Fuel Combustion, Commercial/Institutional, Distillate Oil, Total: Boilers and IC Engines
Urban	2103005000	Stationary Source Fuel Combustion, Commercial/Institutional, Residual Oil, Total: All Boiler Types
Urban	2103006000	Stationary Source Fuel Combustion, Commercial/Institutional, Natural Gas, Total: Boilers and IC Engines
Urban	2103007000	Stationary Source Fuel Combustion, Commercial/Institutional, Liquified Petroleum Gas (LPG), Total: All Combustor Types
Pop	2104002000	Stationary Source Fuel Combustion, Residential, Bituminous/Subbituminous Coal, Total: All Combustor Types
Pop	2104004000	Stationary Source Fuel Combustion, Residential, Distillate Oil, Total: All Combustor Types
Pop	2104005000	Stationary Source Fuel Combustion, Residential, Residual Oil, Total: All Combustor Types
Pop	2104006000	Stationary Source Fuel Combustion, Residential, Natural Gas, Total: All Combustor Types
Pop	2104007000	Stationary Source Fuel Combustion, Residential, Liquified Petroleum Gas (LPG), Total: All Combustor Types
Pop	2104008001	Stationary Source Fuel Combustion, Residential, Wood, Fireplaces
Pop	2104008010	Stationary Source Fuel Combustion, Residential, Wood, Woodstoves: General
Rural	2260001020	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Recreational Equipment, Snowmobiles
Rural	2260001030	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Recreational Equipment, Offroad Motorcycles/ATVs
Rural	2260001060	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Recreational Equipment, Specialty Vehicles/Carts
Urban	2260002006	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Construction and Mining Equipment, Tampers/Rammers
Urban	2260002009	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Construction and Mining Equipment, Plate Compactors
Urban	2260002021	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Construction and Mining Equipment, Paving Equipment
Urban	2260002039	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Construction and Mining Equipment, Concrete/Industrial Saws
Urban	2260002054	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Construction and Mining Equipment, Crushing/Processing Equipment
Urban	2260003030	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Industrial Equipment, Sweepers/Scrubbers
Urban	2260003040	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Industrial Equipment, Other General Industrial Equipment
Pop	2260004015	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Rotary Tillers < 6 HP (Residential)
Pop	2260004016	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Rotary Tillers < 6 HP (Commercial)
Pop	2260004020	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Chain Saws < 6 HP (Residential)
Pop	2260004021	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Chain Saws < 6 HP (Commercial)
Pop	2260004025	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Trimmers/Edgers/Brush Cutters (Residential)
Pop	2260004026	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Trimmers/Edgers/Brush Cutters (Commercial)
Pop	2260004030	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Leafblowers/Vacuums (Residential)
Pop	2260004031	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Leafblowers/Vacuums (Commercial)
Pop	2260004035	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Snowblowers (Residential)
Pop	2260004036	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Snowblowers (Commercial)
Ag	2260005035	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Agricultural Equipment, Sprayers
Ag	2260005050	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Agricultural Equipment, Hydro-power Units
Urban	2260006005	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Commercial Equipment, Generator Sets
Urban	2260006010	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Commercial Equipment, Pumps

Spatial Surrogate	SCC	Source Category Description
Rural	2260007005	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Logging Equipment, Chain Saws > 6 HP
Rural	2265001020	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, Snowmobiles
Rural	2265001030	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, Offroad Motorcycles/ATVs
Rural	2265001050	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, Golf Carts
Rural	2265001060	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, Specialty Vehicles/Carts
Urban	2265002003	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Pavers
Urban	2265002006	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Tampers/Rammers
Urban	2265002009	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Plate Compactors
Urban	2265002015	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Rollers
Urban	2265002021	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Paving Equipment
Urban	2265002024	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Surfacing Equipment
Urban	2265002027	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Signal Boards/Light Plants
Urban	2265002030	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Trenchers
Urban	2265002033	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Bore/Drill Rigs
Urban	2265002039	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Concrete/Industrial Saws
Urban	2265002042	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Cement and Mortar Mixers
Urban	2265002045	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Cranes
Urban	2265002054	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Crushing/Processing Equipment
Urban	2265002057	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Rough Terrain Forklifts
Urban	2265002060	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Rubber Tire Loaders
Urban	2265002066	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Tractors/Loaders/Backhoes
Urban	2265002072	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Skid Steer Loaders
Urban	2265002078	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Dumpers/Tenders
Urban	2265002081	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Other Construction Equipment
Urban	2265003010	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, Aerial Lifts
Urban	2265003020	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, Forklifts
Urban	2265003030	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, Sweepers/Scrubbers
Urban	2265003040	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, Other General Industrial Equipment
Urban	2265003050	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, Other Material Handling Equipment
Urban	2265003060	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, AC\Refrigeration
Urban	2265003070	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, Terminal Tractors
Pop	2265004010	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Lawn Mowers (Residential)
Pop	2265004011	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Lawn Mowers (Commercial)
Pop	2265004015	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Rotary Tillers < 6 HP (Residential)
Pop	2265004016	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Rotary Tillers < 6 HP (Commercial)
Pop	2265004025	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Trimmers/Edgers/Brush Cutters (Residential)
Pop	2265004026	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Trimmers/Edgers/Brush Cutters (Commercial)
Pop	2265004030	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Leafblowers/Vacuums (Residential)
Pop	2265004031	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Leafblowers/Vacuums (Commercial)
Pop	2265004035	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Snowblowers (Residential)

Spatial Surrogate	SCC	Source Category Description
Pop	2265004036	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Snowblowers (Commercial)
Pop	2265004040	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Rear Engine Riding Mowers (Residential)
Pop	2265004041	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Rear Engine Riding Mowers (Commercial)
Pop	2265004046	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Front Mowers (Commercial)
Pop	2265004051	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Shredders < 6 HP (Commercial)
Pop	2265004055	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Lawn and Garden Tractors (Residential)
Pop	2265004056	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Lawn and Garden Tractors (Commercial)
Pop	2265004066	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Chippers/Stump Grinders (Commercial)
Pop	2265004071	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Turf Equipment (Commercial)
Pop	2265004075	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Other Lawn and Garden Equipment (Residential)
Pop	2265004076	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, Other Lawn and Garden Equipment (Commercial)
Ag	2265005010	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, 2-Wheel Tractors
Ag	2265005015	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Agricultural Tractors
Ag	2265005025	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Balers
Ag	2265005030	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Agricultural Mowers
Ag	2265005035	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Sprayers
Ag	2265005040	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Tillers > 6 HP
Ag	2265005045	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Swathers
Ag	2265005050	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Hydro-power Units
Ag	2265005055	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Other Agricultural Equipment
Ag	2265005060	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Irrigation Sets
Urban	2265006005	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Commercial Equipment, Generator Sets
Urban	2265006010	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Commercial Equipment, Pumps
Urban	2265006015	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Commercial Equipment, Air Compressors
Urban	2265006025	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Commercial Equipment, Welders
Urban	2265006030	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Commercial Equipment, Pressure Washers
Rural	2265007010	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Logging Equipment, Shredders > 6 HP
Rural	2265007015	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Logging Equipment, Forest Eqp - Feller/Bunch/Skidder
Area	2265008005	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Airport Ground Support Equipment, Airport Ground Support Equipment
Rural	2267001060	Mobile Sources, LPG, Recreational Equipment, Specialty Vehicles/Carts
Urban	2267003010	Mobile Sources, LPG, Industrial Equipment, Aerial Lifts
Urban	2267003020	Mobile Sources, LPG, Industrial Equipment, Forklifts
Urban	2267003030	Mobile Sources, LPG, Industrial Equipment, Sweepers/Scrubbers
Urban	2267003040	Mobile Sources, LPG, Industrial Equipment, Other General Industrial Equipment
Urban	2267003050	Mobile Sources, LPG, Industrial Equipment, Other Material Handling Equipment
Urban	2267003070	Mobile Sources, LPG, Industrial Equipment, Terminal Tractors
Pop	2267004066	Mobile Sources, LPG, Lawn and Garden Equipment, Chippers/Stump Grinders (Commercial)
Ag	2267005050	Mobile Sources, LPG, Agricultural Equipment, Hydro-power Units
Ag	2267005055	Mobile Sources, LPG, Agricultural Equipment, Other Agricultural Equipment
Urban	2267006005	Mobile Sources, LPG, Commercial Equipment, Generator Sets

Spatial Surrogate	SCC	Source Category Description
Urban	2267006010	Mobile Sources, LPG, Commercial Equipment, Pumps
Urban	2267006015	Mobile Sources, LPG, Commercial Equipment, Air Compressors
Urban	2267006025	Mobile Sources, LPG, Commercial Equipment, Welders
Urban	2267006030	Mobile Sources, LPG, Commercial Equipment, Pressure Washers
Area	2267008005	Mobile Sources, LPG, Airport Ground Support Equipment, Airport Ground Support Equipment
Urban	2268003020	Mobile Sources, CNG, Industrial Equipment, Forklifts
Urban	2268003060	Mobile Sources, CNG, Industrial Equipment, AC\Refrigeration
Ag	2268005055	Mobile Sources, CNG, Agricultural Equipment, Other Agricultural Equipment
Ag	2268005060	Mobile Sources, CNG, Agricultural Equipment, Irrigation Sets
Urban	2268006005	Mobile Sources, CNG, Commercial Equipment, Generator Sets
Urban	2268006010	Mobile Sources, CNG, Commercial Equipment, Pumps
Urban	2268006015	Mobile Sources, CNG, Commercial Equipment, Air Compressors
Urban	2268006020	Mobile Sources, CNG, Commercial Equipment, Gas Compressors
Rural	2270001060	Mobile Sources, Off-highway Vehicle Diesel, Recreational Equipment, Specialty Vehicles/Carts
Urban	2270002003	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Pavers
Urban	2270002009	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Plate Compactors
Urban	2270002015	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Rollers
Urban	2270002018	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Scrapers
Urban	2270002021	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Paving Equipment
Urban	2270002024	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Surfacing Equipment
Urban	2270002027	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Signal Boards/Light Plants
Urban	2270002030	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Trenchers
Urban	2270002033	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Bore/Drill Rigs
Urban	2270002036	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Excavators
Urban	2270002039	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Concrete/Industrial Saws
Urban	2270002042	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Cement and Mortar Mixers
Urban	2270002045	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Cranes
Urban	2270002048	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Graders
Urban	2270002051	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Off-highway Trucks
Urban	2270002054	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Crushing/Processing Equipment
Urban	2270002057	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Rough Terrain Forklifts
Urban	2270002060	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Rubber Tire Loaders
Urban	2270002063	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Rubber Tire Tractor/Dozers
Urban	2270002066	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Tractors/Loaders/Backhoes
Urban	2270002069	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Crawler Tractor/Dozers
Urban	2270002072	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Skid Steer Loaders
Urban	2270002075	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Off-highway Tractors
Urban	2270002078	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Dumpers/Tenders
Urban	2270002081	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Other Construction Equipment
Rural	2270003010	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, Aerial Lifts

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Spatial Surrogate	SCC	Source Category Description
Rural	2270003020	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, Forklifts
Rural	2270003030	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, Sweepers/Scrubbers
Rural	2270003040	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, Other General Industrial Equipment
Rural	2270003050	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, Other Material Handling Equipment
Rural	2270003060	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, AC\Refrigeration
Rural	2270003070	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, Terminal Tractors
Pop	2270004031	Mobile Sources, Off-highway Vehicle Diesel, Lawn and Garden Equipment, Leafblowers/Vacuums (Commercial)
Pop	2270004036	Mobile Sources, Off-highway Vehicle Diesel, Lawn and Garden Equipment, Snowblowers (Commercial)
Pop	2270004046	Mobile Sources, Off-highway Vehicle Diesel, Lawn and Garden Equipment, Front Mowers (Commercial)
Pop	2270004056	Mobile Sources, Off-highway Vehicle Diesel, Lawn and Garden Equipment, Lawn and Garden Tractors (Commercial)
Pop	2270004066	Mobile Sources, Off-highway Vehicle Diesel, Lawn and Garden Equipment, Chippers/Stump Grinders (Commercial)
Pop	2270004071	Mobile Sources, Off-highway Vehicle Diesel, Lawn and Garden Equipment, Turf Equipment (Commercial)
Pop	2270004076	Mobile Sources, Off-highway Vehicle Diesel, Lawn and Garden Equipment, Other Lawn and Garden Equipment (Commercial)
Ag	2270005010	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, 2-Wheel Tractors
Ag	2270005015	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Agricultural Tractors
Ag	2270005020	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Combines
Ag	2270005025	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Balers
Ag	2270005030	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Agricultural Mowers
Ag	2270005035	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Sprayers
Ag	2270005040	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Tillers > 6 HP
Ag	2270005045	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Swathers
Ag	2270005050	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Hydro-power Units
Ag	2270005055	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Other Agricultural Equipment
Ag	2270005060	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Irrigation Sets
Urban	2270006005	Mobile Sources, Off-highway Vehicle Diesel, Commercial Equipment, Generator Sets
Urban	2270006010	Mobile Sources, Off-highway Vehicle Diesel, Commercial Equipment, Pumps
Urban	2270006015	Mobile Sources, Off-highway Vehicle Diesel, Commercial Equipment, Air Compressors
Urban	2270006025	Mobile Sources, Off-highway Vehicle Diesel, Commercial Equipment, Welders
Urban	2270006030	Mobile Sources, Off-highway Vehicle Diesel, Commercial Equipment, Pressure Washers
Rural	2270007010	Mobile Sources, Off-highway Vehicle Diesel, Logging Equipment, Shredders > 6 HP
Rural	2270007015	Mobile Sources, Off-highway Vehicle Diesel, Logging Equipment, Forest Eqp - Feller/Bunch/Skidder
Area	2270008005	Mobile Sources, Off-highway Vehicle Diesel, Airport Ground Support Equipment, Airport Ground Support Equipment
Rural	2275001000	Mobile Sources, Aircraft Military Aircraft, Total
Rural	2275020000	Mobile Sources, Aircraft Commercial Aircraft, Total
Rural	2275050000	Mobile Sources, Aircraft General Aviation, Total
Area	2275900000	Mobile Sources, Aircraft, Refueling: All Fuels, All Processes
Water	2282005010	Mobile Sources, Pleasure Craft, Gasoline 2-Stroke, Outboard
Water	2282005015	Mobile Sources, Pleasure Craft, Gasoline 2-Stroke, Personal Water Craft
Water	2282010005	Mobile Sources, Pleasure Craft, Gasoline 4-Stroke, Inboard/Sterndrive
Water	2282020005	Mobile Sources, Pleasure Craft, Diesel, Inboard/Sterndrive

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Spatial Surrogate	SCC	Source Category Description
Water	2282020010	Mobile Sources, Pleasure Craft, Diesel, Outboard
Rural	2285000000	Mobile Sources, Railroad Equipment, All Fuels, Total
Rural	2285002015	Mobile Sources, Railroad Equipment, Diesel, Railway Maintenance
Rural	2285004015	Mobile Sources, Railroad Equipment, Gasoline, 4-Stroke, Railway Maintenance
Rural	2285006015	Mobile Sources, Railroad Equipment, LPG, Railway Maintenance
Urban	2302080002	Industrial Processes, Food and Kindred Products: SIC 20, Miscellaneous Food and Kindred Products, Refrigeration
Urban	2401005000	Solvent Utilization, Surface Coating, Auto Refinishing: SIC 7532, Total: All Solvent Types
Urban	2401015000	Solvent Utilization, Surface Coating, Factory Finished Wood: SIC 2426 thru 242, Total: All Solvent Types
Urban	2401020000	Solvent Utilization, Surface Coating, Wood Furniture: SIC 25, Total: All Solvent Types
Urban	2401050000	Solvent Utilization, Surface Coating, Miscellaneous Finished Metals: SIC 34 - (341 + 3498), Total: All Solvent Types
Urban	2401055000	Solvent Utilization, Surface Coating, Machinery and Equipment: SIC 35, Total: All Solvent Types
Urban	2401070000	Solvent Utilization, Surface Coating, Motor Vehicles: SIC 371, Total: All Solvent Types
Water	2401080000	Solvent Utilization, Surface Coating, Marine: SIC 373, Total: All Solvent Types
Urban	2401085000	Solvent Utilization, Surface Coating, Railroad: SIC 374, Total: All Solvent Types
Urban	2401090000	Solvent Utilization, Surface Coating, Miscellaneous Manufacturing, Total: All Solvent Types
Urban	2401100000	Solvent Utilization, Surface Coating, Industrial Maintenance Coatings, Total: All Solvent Types
Urban	2401200000	Solvent Utilization, Surface Coating, Other Special Purpose Coatings, Total: All Solvent Types
Urban	2415230000	Solvent Utilization, Degreasing, Electronic and Other Elec. (SIC 36): Conveyerized Degreasing, Total: All Solvent Types
Urban	2415245000	Solvent Utilization, Degreasing, Miscellaneous Manufacturing (SIC 39): Conveyerized Degreasing, Total: All Solvent Types
Urban	2415345000	Solvent Utilization, Degreasing, Miscellaneous Manufacturing (SIC 39): Cold Cleaning, Total: All Solvent Types
Urban	2415360000	Solvent Utilization, Degreasing, Auto Repair Services (SIC 75): Cold Cleaning, Total: All Solvent Types
Pop	2420000000	Solvent Utilization, Dry Cleaning, All Processes, Total: All Solvent Types
Urban	2425000000	Solvent Utilization, Graphic Arts, All Processes, Total: All Solvent Types
Pop	2460000000	Solvent Utilization, Miscellaneous Non-industrial: Consumer and Commercial, All Processes, Total: All Solvent Types
Pop	2501060050	Storage and Transport, Petroleum and Petroleum Product Storage, Gasoline Service Stations, Stage 1: Total
Pop	2501060100	Storage and Transport, Petroleum and Petroleum Product Storage, Gasoline Service Stations, Stage 2: Total
Pop	2501060200	Storage and Transport, Petroleum and Petroleum Product Storage, Gasoline Service Stations, Underground Tank: Total
Urban	2505030120	Storage and Transport, Petroleum and Petroleum Product Transport, Truck, Gasoline
Urban	2610000100	Waste Disposal, Treatment, and Recovery, Open Burning, All Categories, Yard Waste - Leaf Species Unspecified
Pop	2610030000	Waste Disposal, Treatment, and Recovery, Open Burning, Residential, Household Waste (use 26-10-000-xxx for Yard Wastes)
Ag	2805000000	Miscellaneous Area Sources, Agriculture Production - Livestock, Agriculture - Livestock, Total
Ag	2805001000	Miscellaneous Area Sources, Agriculture Production - Livestock, Beef Cattle Feedlots, Total (also see 2805020000)
Pop	2810025000	Miscellaneous Area Sources, Other Combustion, Charcoal Grilling, Total
Pop	2810030000	Miscellaneous Area Sources, Other Combustion, Structure Fires, Total
Urban	2810050000	Miscellaneous Area Sources, Other Combustion, Motor Vehicle Fires, Total

Figures 12-2 through 12-15 EPS2 spatial surrogates for the modeling grid used in developing gridded emission estimates. The grid is defined on a Universal TransverseMercator (UTM) projection for zone 11 at a horizontal resolution of 1 km by 1 km.

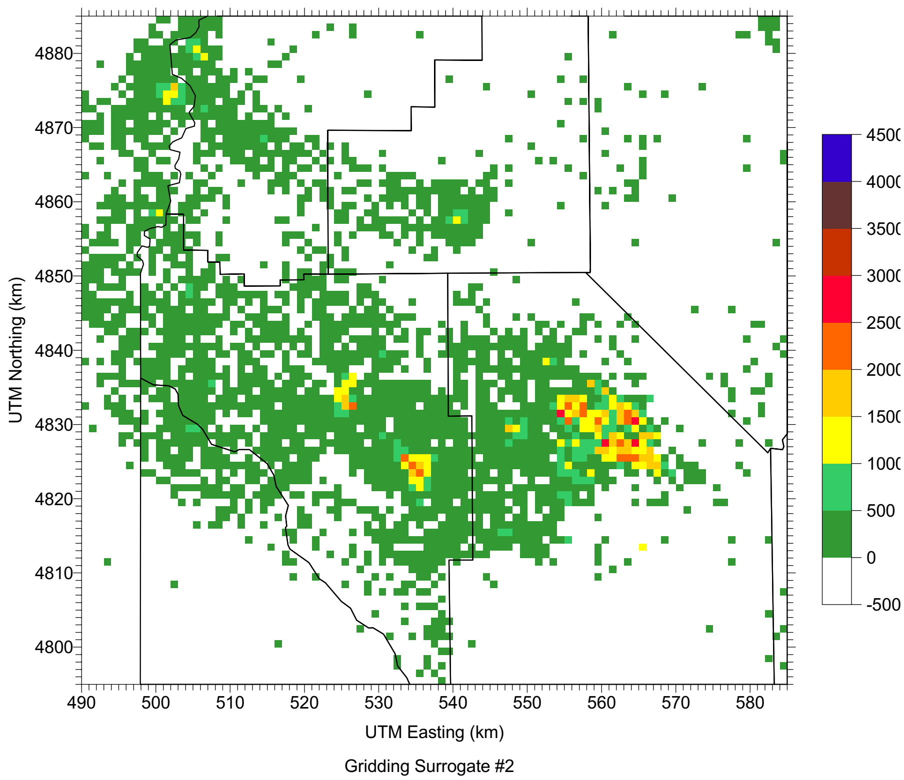

Figure 12-2. Spatial distribution for EPS2 population surrogate.

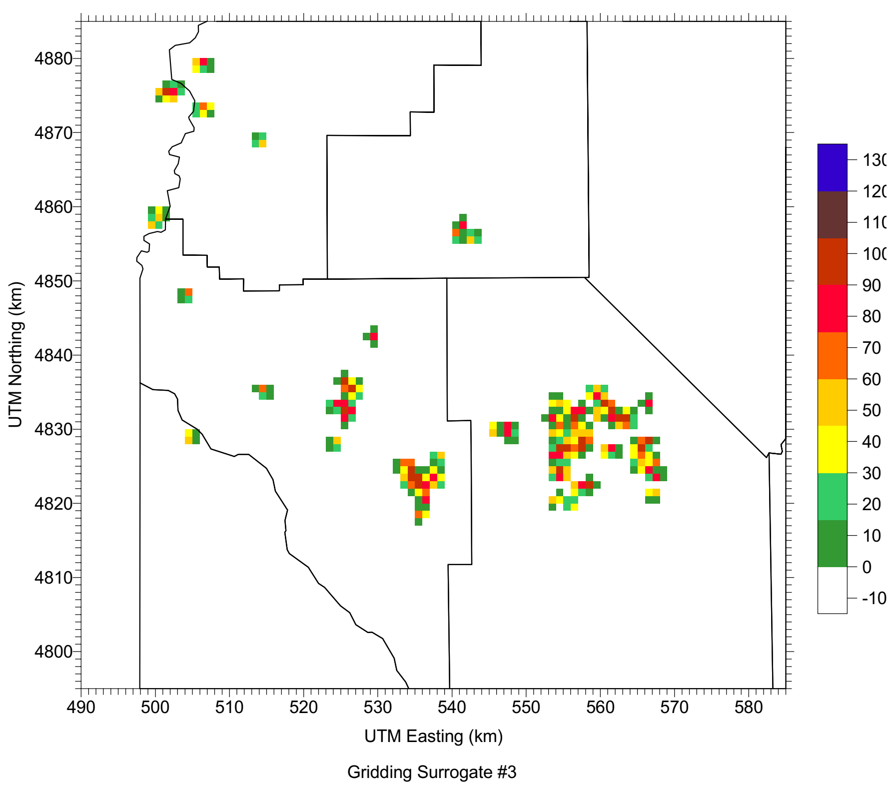

Figure 12-3. Spatial distribution for EPS2 residential land surrogate.

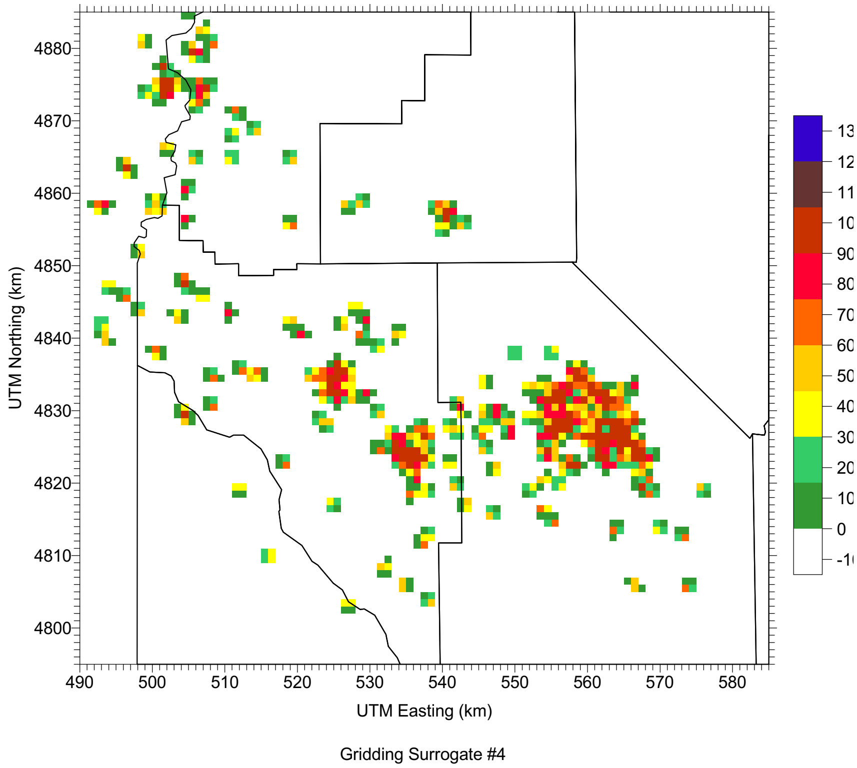

Figure 12-4. Spatial distribution for EPS2 urban land surrogate.

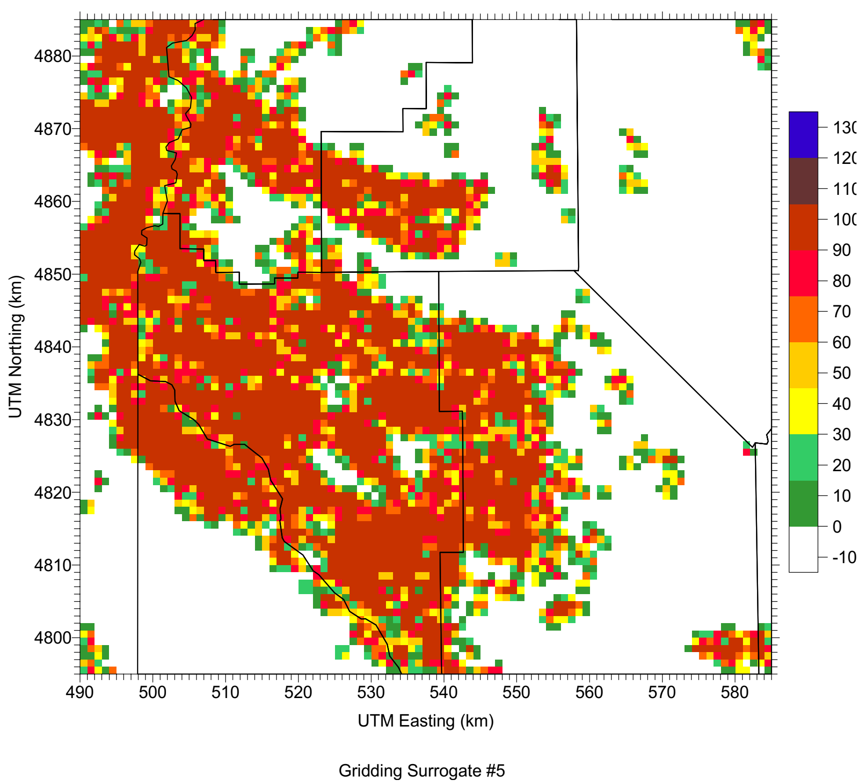

Figure 12-5. Spatial distribution for EPS2 agricultural land surrogate.

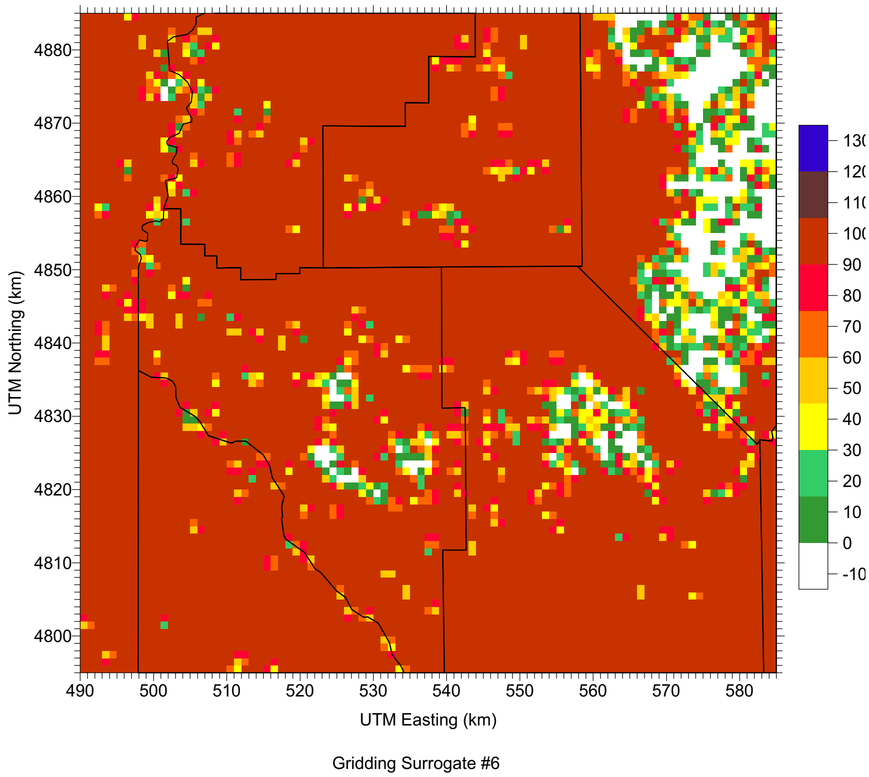

Figure 12-6. Spatial distribution for EPS2 range land surrogate.

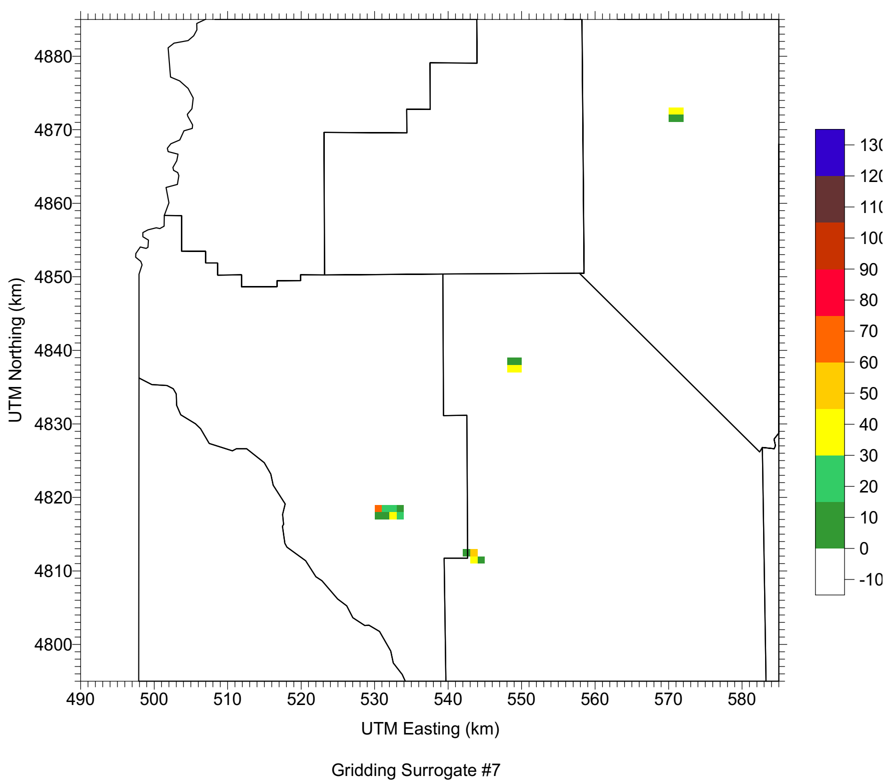

Figure 12-7. Spatial distribution for EPS2 deciduous forest land surrogate.

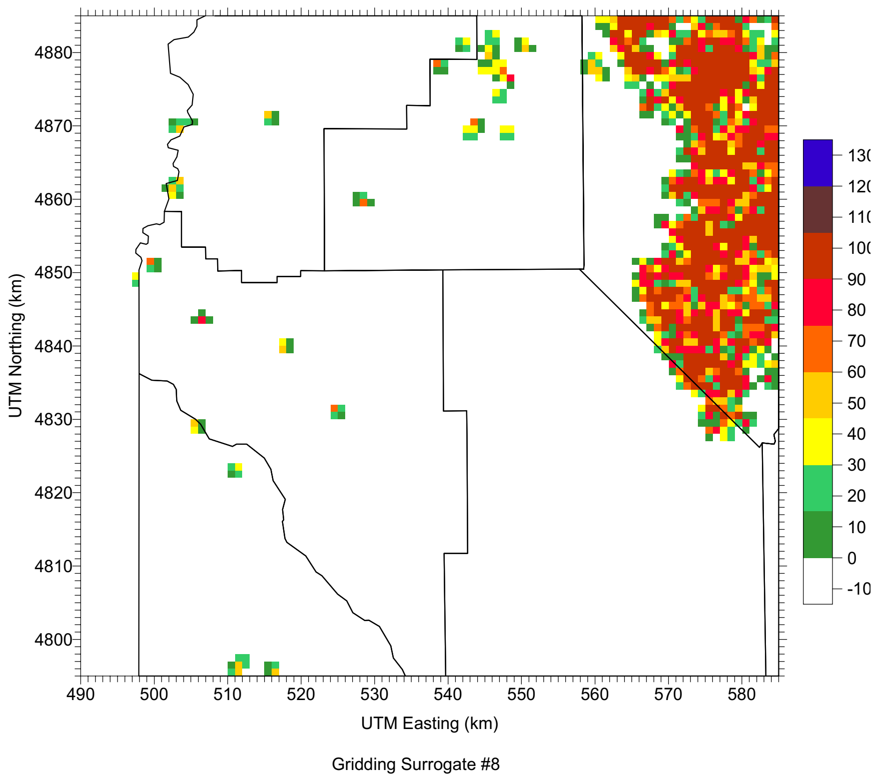

Figure 12-8. Spatial distribution for EPS2 coniferous forest land surrogate.

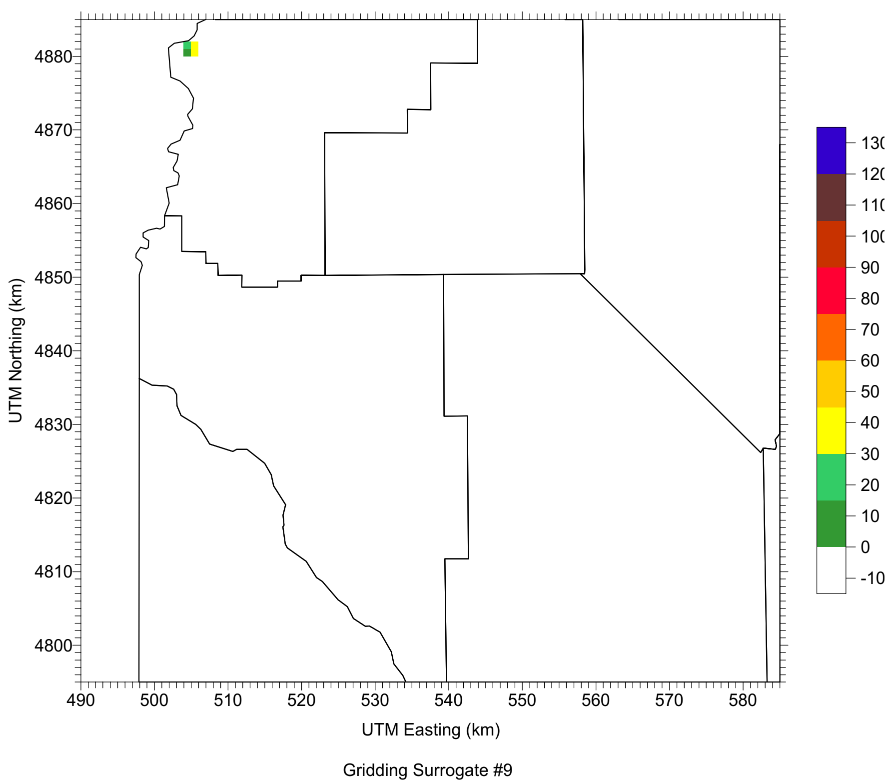

Figure 12-9. Spatial distribution for EPS2 mixed forest land surrogate.

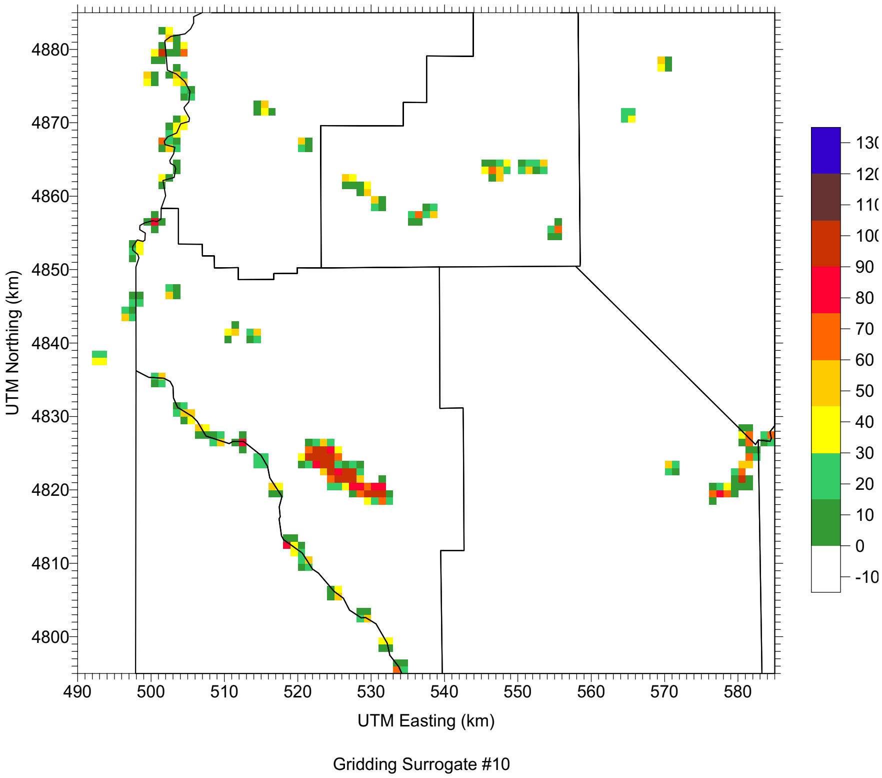

Figure 12-10. Spatial distribution for EPS2 water surrogate.

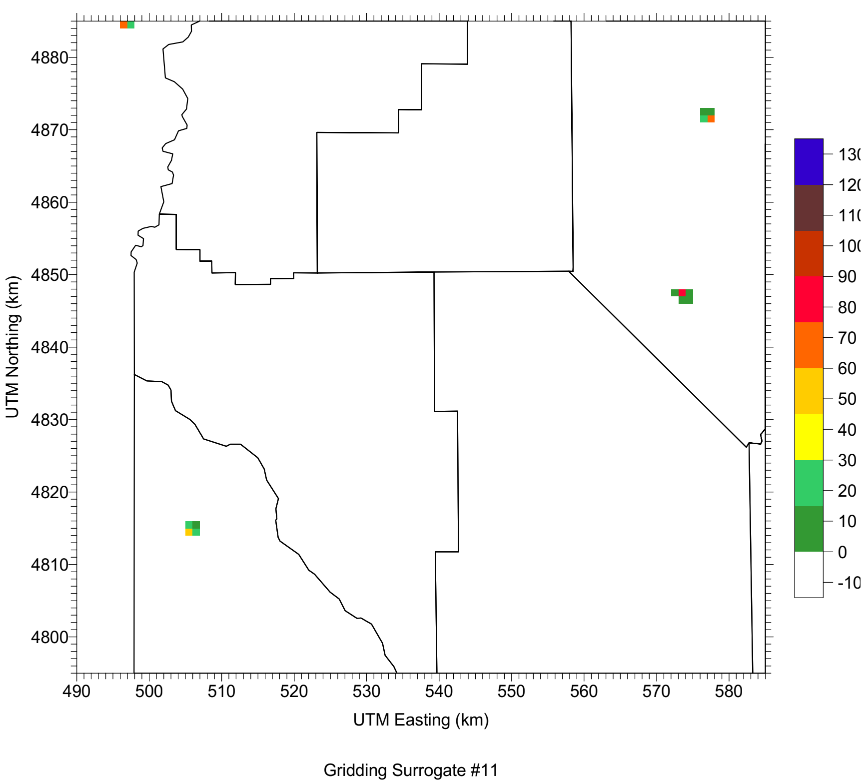

Figure 12-11. Spatial distribution for EPS2 barren land surrogate.

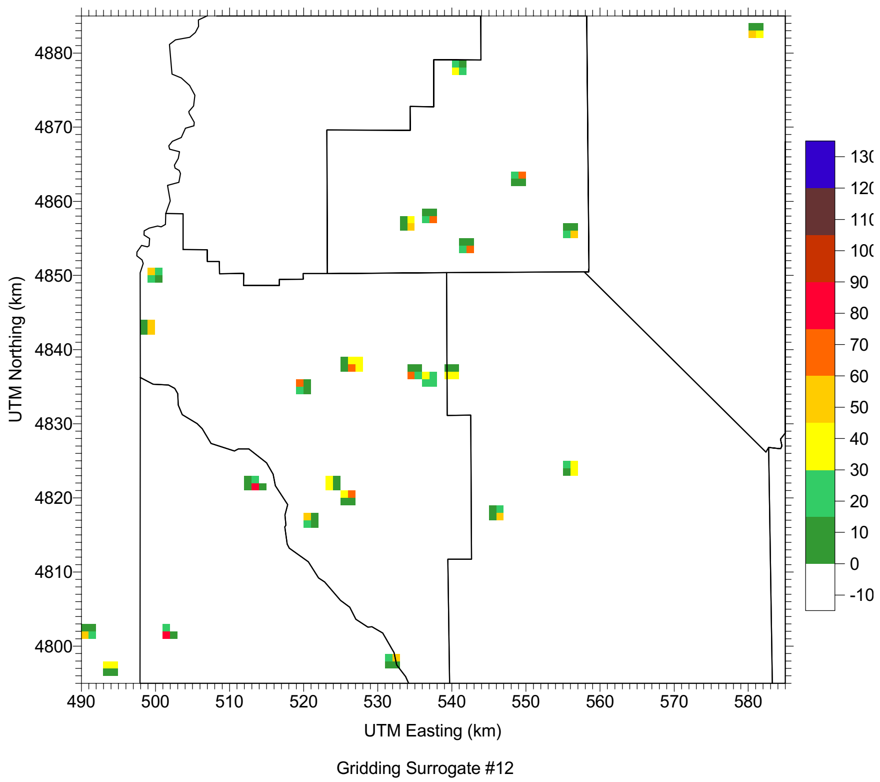

Figure 12-12. Spatial distribution for EPS2 non-forested wetlands surrogate.

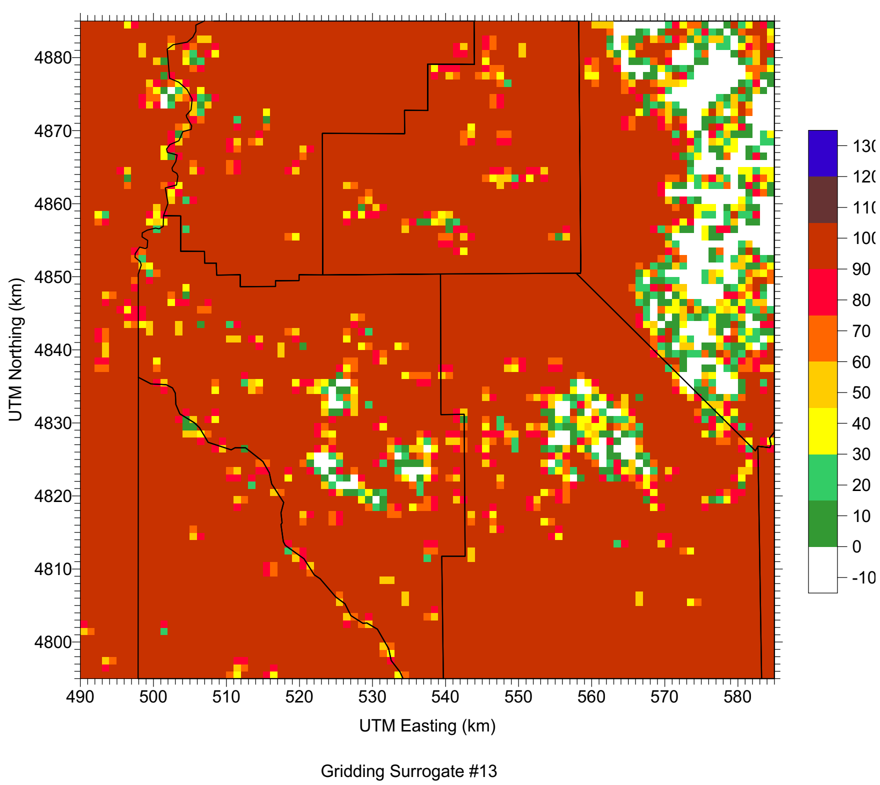

Figure 12-13. Spatial distribution for EPS2 mixed range and agricultural land surrogate.

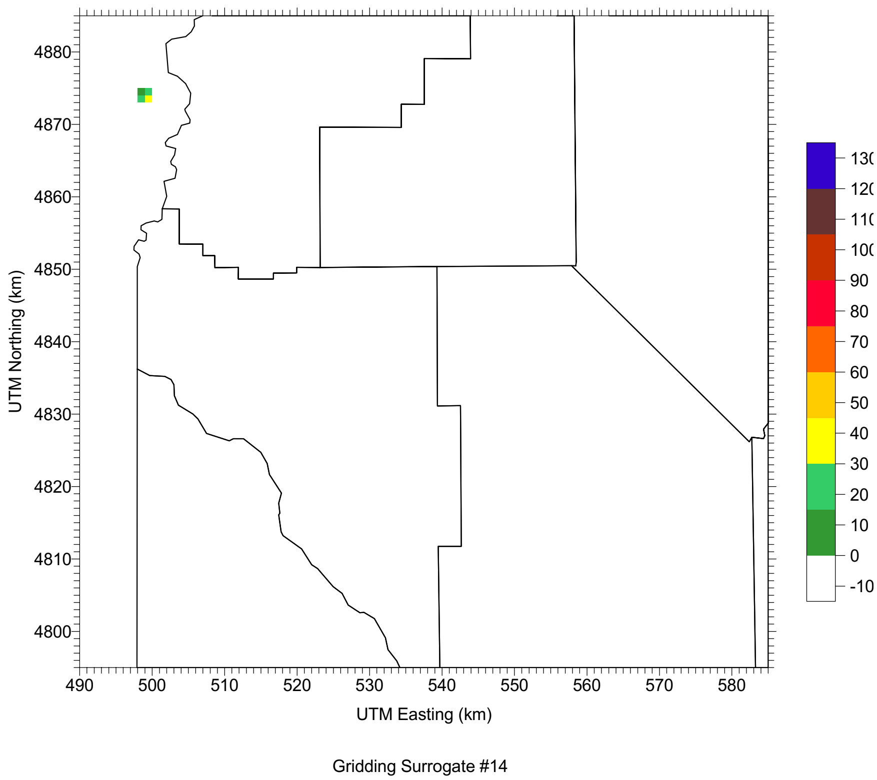

Figure 12-14. Spatial distribution for EPS2 urban/recreational grass land surrogate.

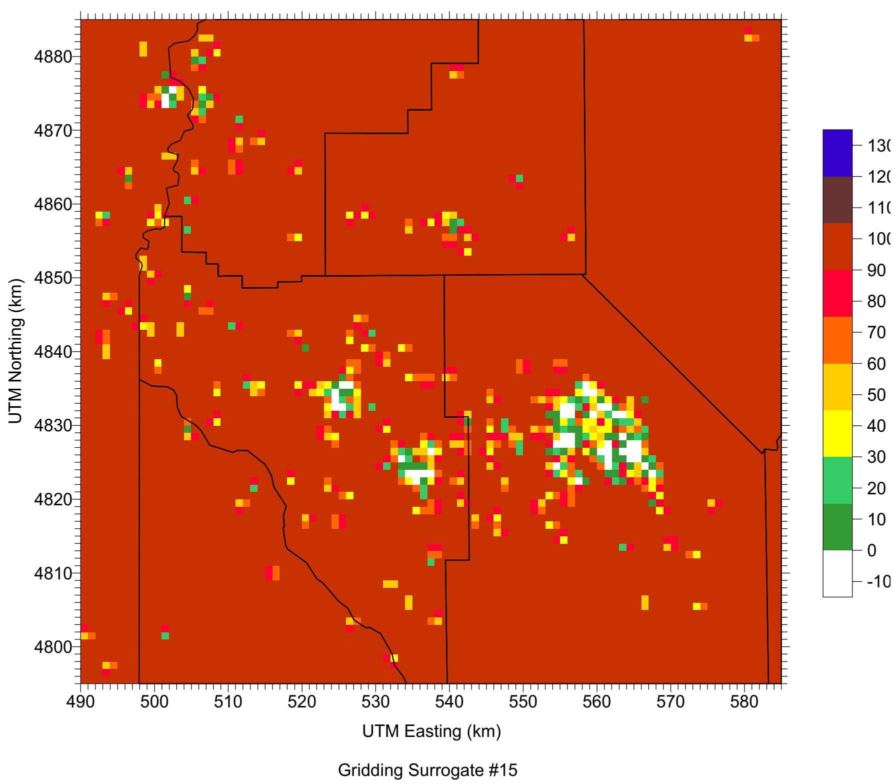

Figure 12-15. Spatial distribution for EPS2 rural land surrogate.

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Appendix A
Point Sources

Point Source Questionnaire
Emissions Inventory Forms
Point Source Questionnaire QA/QC Checklist
Database QA/QC Checklist

INDUSTRIAL POINT SOURCE QUESTIONNAIRE

IN SUPPORT OF THE ADA COUNTY PM_{10} MAINTENANCE PLAN

INDUSTRIAL POINT SOURCE QUESTIONNAIRE
INSTRUCTIONS AND FORMS

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BLANK EMISSIONS INVENTORY FORMS

WHO MUST COMPLETE AND RETURN FORMS?

- You were sent this packet because your facility has been identified as a potential emitter of PM_{10} or its precursors (i.e., NO_x, SO_x, VOC, NH_3).
- ALL facilities that receive an inventory packet MUST complete and submit all applicable forms.
- Even if your facility currently has no emissions of these pollutants, DEQ must document that information.
- DEQ must also document the maximum emissions that could be generated at each facility.

BASE YEAR AND POLLUTANTS BEING INVENTORIED

This emissions inventory is intended to obtain information about PM_{10} emissions and precursors which can form PM_{10} for the year of 1999. The following pollutants must be included in this inventory:

1. Particulate Matter < 10 micrometers in aerodynamic diameter (PM_{10}).
2. Nitrogen Oxides (NO_x).
3. Sulfur Oxides (SO_x).
4. Volatile Organic Compounds (VOCs).
5. Carbon Monoxide (CO).
6. Ammonia (NH_3).

SUBMITTING FORMS

You must return the completed emissions inventory forms to DEQ NO LATER THAN May 1, 2001. Material must be sent to:

Idaho Department of Environmental Quality
Attention: Mike McGown/Point Source Survey
1445 North Orchard Street
Boise, ID 83703

We recommend that you make copies of the completed emissions inventory forms and other information that you submit to DEQ.

ID NUMBERS

- You will be asked to assign an ID number to each source of emissions and each control device.
- Numbers may be numerical (i.e., 1, 2, 3, etc.) or alphanumeric (i.e. A-1, A-2, B-1, B-2, B-3 etc).
- Do not duplicate any numbers – each number should be unique and describe only ONE specific source or control.
- Please use the same ID # for each source in all of the forms and information your provide.

GENERAL INSTRUCTIONS

- Please do not leave any blank lines in the forms. Record an answer for **EACH** line on the required forms.
- Enter "N/A" for any fields that are not applicable.
- If you can not get specific data to answer a question, please estimate as closely as possible.

- Feel free to attach additional pages whenever necessary.
- Detailed instructions on how to fill out the forms and complete the other requirements begin on page 3.

QUESTIONS?

For any questions regarding this survey or the forms, please contact Mike McGown, State of Idaho Department of Environmental Quality, at (208) 373-0575.

FORMS THAT MUST BE COMPLETED

- There are 14 different forms plus a checklist included in this packet.
- The checklist, FORM-A, FORM-VOC, FORM-EPISODE, and FORM-SUM must be filled out and returned to DEQ by EACH facility that receives this packet.
- The requirement for completing all other forms depends on the type of equipment and processes at your facility.
- Forms B through H request information about specific emissions sources.
- Depending on the number of emissions sources, you may need to fill out more than one copy of a particular form (e.g., separate FORM-Bs are required for each type of combustion equipment).

Form	Description	Requirement
Checklist		
	Checklist to ensure that all required information is completed and returned	Required for all facilities.
Facility Information		
FORM-A	Facility description, contact information and location.	Required for all facilities.
Information Forms		
FORM-B	Combustion Equipment Information Form	One of the ***Information Forms*** is required for each emission source in the facility.
FORM-C	Materials Transport, Handling, Storage Information Form	
FORM-D	General Emission Source Information Form	
FORM-E	Stack Information Form	
FORM-F	Controls Information Form	Required for each emissions control device or strategy used in the facility.
Emissions Forms		
FORM-G	Emissions Estimation Form	Either FORM-G – Emissions Estimation Form or one of the four versions of FORM-H – Fugitive Dust Emissions Form must be submitted for each emissions source at the facility.
Fugitive Dust Emissions Forms		
FORM-H1	Transfer, Conveying Operations Dust Form	
FORM-H2	Storage Piles Dust Form	
FORM-H3	Unpaved Roads Dust Form	
FORM-H4	Paved Roads Dust Form	
FORM-VOC	Evaporative VOC Emission Form	Required for facilities using VOC-containing substances (e.g., solvents, coatings, etc.).
Temporal Allocation Forms		
FORM-EPISODE	Operation Schedule During December 20-26, 1999	Required for all facilities.
Emissions Summaries		
FORM-SUM	Emissions Summary Form	Required for all facilities.

INSTRUCTIONS FOR INDIVIDUAL FORMS AND OTHER REQUIREMENTS

- Instructions are provided for portions that may need further explanation. Instructions are not provided for EACH step of the forms.
- If you have any questions about what information to include in your responses, please contact Mike McGown, State of Idaho Department of Environmental Quality, at (208) 373-0575.

INVENTORY CHECKLIST

REQUIRED FOR ALL FACILITIES

- Please fill out the checklist to ensure that all required forms are filled out and submitted to DEQ on time.

FORM-A: FACILITY INFORMATION

REQUIRED FOR ALL FACILITIES

- This is a two-page form.

Side One

Description of business: Please give a short (1-2 sentence) description of the facility.

SIC Code: Please provide your facility's Standard Industrial Classification (SIC) code. For an index of SIC codes see the Occupational Safety and Health Administration (OSHA) website at: http://www.osha.gov (Click on "Library" then on "Statistics and Inspection Data" then on "SIC Manual").

Facility Location Coordinates:

- Give the UTM (Universal Transverse Mercator) coordinates for your facility.
- This information must be given in kilometers and must be accurate to at least 50 meters.
- This information can be obtained from United States Geological Survey maps or other survey information.
- This information should be for the center of your facility if possible.

If the coordinates are **not** provided for the center of your facility, describe the location that corresponds the coordinates you give.

List emissions sources:

- List each air pollution emission source at this facility.
- Provide a very brief description of the operation or process that generates emissions.
- List the Source ID number for each. Information about the Source ID number is given on page 1 of these instructions.
- Please use the same Source ID number for each source in all of the forms and information your provide.

Side Two

Description of process flow:

- Provide a step-by-step textual description of the process flow at your facility. Limit your description to 1 page of typewritten text if possible.

Facilities with 1999 annual emissions of >25 tons per year (tpy) of PM_{10} or >100 tpy of NO_x, SO_x, VOC, CO, or NH_3:

- Please provide a process flow diagram, a scaled plot plan that indicates emissions sources, building dimensions, and detailed information about any emissions stacks.

FORM-B: COMBUSTION EQUIPMENT INFORMATION

- Use this form if you have any type of combustion equipment at your facility.
- Complete one form for **EACH** combustion unit at the facility, including boilers, furnaces, generators or fuel burning equipment.

Equipment Description: Describe the combustion device and how it is used in the process (e.g., boiler to heat water, combustion turbine for cogeneration, etc.).

Sulfur Content of Fuel: Obtain from fuel supplier.

Ash Content: Obtain from fuel supplier.

Fuel Heat Content: Obtain from fuel supplier.

FORM-C: MATERIALS TRANSPORT, HANDLING, STORAGE INFORMATION

- Use this form if you have any type of materials transport, handling, or storage operations at your facility.
- Complete one form for **EACH** emission source associated with the transport, handling, or storage of materials. This can include sources such as storage piles or silos, conveyor transfer points, or loading and unloading of materials.

Equipment/Operation Description: Provide information on the types and amounts of materials processed and the equipment used in the process.

FORM-D: GENERAL EMISSION SOURCE INFORMATION

- Complete one form for **EACH** emissions source that is not covered by either FORM-B or FORM-C.

Operation/Equipment Description: Provide information on the types and amounts of materials processed and the equipment used in the process.

Production Rates: Specify the units associated with the production source (i.e. pounds/hour, gallons/year). To avoid confusion, please do not abbreviate any of the units.

FORM-E: STACK INFORMATION

- Use this form if you have any emissions released to the atmosphere through a stack at your facility.

- Complete this form for **EACH** stack in the facility that emits PM_{10}, NO_x, SO_X, VOCs, CO, or NH_3.

Inside Stack Diameter:
- Provide information about the diameter of the inside (opening) of the stack.
- This form is designed to record information on stacks with **round** cross-sectional areas. If your stack cross-sectional area is **square**, you must convert to an equivalent diameter using the following equation:

$$\text{Diameter} = 2 \times \sqrt{\frac{L \times W}{3.14}}$$

L = inside length of the stack (Feet)
W = inside width of the stack (Feet)

Stack Location: Provide actual stack location, not the center of the facility or other common location. If you do not have accurate stack location information, please indicate this on the form. This information must be given in kilometers and must be accurate to at least 50 meters.

FORM-F: EMISSIONS CONTROLS INFORMATION

- Use this form if you utilize any emissions control devices or strategies at your facility.
- Complete this form for **EACH** control device or strategy used at the facility. If more than one control is used for a particular process/operation/equipment, you must fill out a separate form for EACH.

Control Codes: listed in Table 1 of this packet.

% Control Efficiency: Percentage control efficiency (based on manufacturer's specifications, test data, engineering estimates, AP-42, etc.).

Control Efficiency Reference Code (CER):
- Decide which code from the list at the bottom of the form applies.
- If the control efficiency used in this form is based on test data you must attach a detailed explanation of the method used, relevant parameters (e.g., temperature, fuel, etc.) associated with the test, and why the percent efficiency listed is appropriate.

Comments/Explanation: Provide a detailed information about where you obtained the control efficiency information (e.g., chapter numbers from AP-42, assumptions used in engineering estimates, etc).

FORM-G: EMISSIONS ESTIMATING - EMISSION FACTORS

- Use this form if you want to estimate emissions using emission factors. Emission factors relate the amount of emissions released to the level of emissions-generating activity (e.g., pounds of PM_{10} emitted per ton of coal burned).
- Complete this form for **EACH** source where emissions are estimated using emission factors.

SCC codes: listed in Table 2 of this packet.

Emissions Estimation Table, 1999 Activity Level: Determine activity level for the entire year, e.g. total fuel consumed, total throughput, etc.

Emissions Factor Values:
- This data can come from EPA factors, source testing, monitoring, etc.
- Do not use the results from EPA Method 5 and 5A source tests for estimating PM_{10} emissions. These source methods do not estimate PM_{10} emissions.
- Table 2 provides EPA's most current recommended emissions estimation factors for many sources. This list was extracted from EPA's Factor Information Retrieval Data System (FIRE database).

Emissions Factor Unit: Don't forget to include the units for the specific emissions factor value.

Emissions Factor Code:
- Decide which code from the list at the bottom of the form applies.
- If the emissions factor used in this form is based on test data you must attach a detailed explanation of the method used, relevant parameters (e.g., temperature, fuel, etc.) associated with the test, and why the percent efficiency listed is appropriate.

Overall Control Efficiency:
- If there are no control devices used, then put a "0" in the table.
- If one control device is used, then enter the percentage (%) control efficiency from FORM-F in the table.
- If two or more control devices are used, then the overall control efficiency must be calculated as follows: (Attach calculations on a separate page.)

$$CE = CE_1 + \left[(100 - CE_1) \times \frac{CE_2}{100}\right]$$

Where: CE = Overall control efficiency (%)
CE_1 = Control efficiency of device #1 (%)
CE_2 = Control efficiency of device #2 (%)

Example: An emissions unit is controlled with two devices. The first control device has a control efficiency equal to 35% and the second control device has a control efficiency equal to: 0.40%. The overall control efficiency is equal to
$35 + [(100-35) \times 0.40] = 35 + 26 = 61\%$.

Emissions:
- Calculate emissions using the following formula:

$$E = A \times EF \times \left(1 - \frac{CE}{100}\right)$$

Where: E = Emissions (pounds/year)
A = Activity level (activity unit/year)
EF = Emission factor [value and units] (pounds/activity unit)
CE = Overall control efficiency (%)

- Make sure that units are consistent throughout the equation (i.e., do not mix pounds and tons).
- Emissions must be recorded as pounds per year.

FORM-H1: FUGITIVE DUST EMISSIONS - TRANSFER, CONVEYING OPERATIONS

- Use this form OR FORM-G if you have any type of transfer or conveying operations at your facility.
  - Transfer or conveying operations can include, but are not limited to, the following types of procedures: 1) truck dumping on a pile; 2) loading out from a pile to a truck; and 3) continuous drop operations from belt or pneumatic conveyors.
  - Use THIS form if you want to estimate the emissions for this source with an emission factor that reflects the effects of moisture content.
  - Use the FORM-G (EMISSIONS ESTIMATING FORM) if you want to estimate the emissions from this source using an emission factor from AP-42 or Table 2 of this packet, which do NOT reflect the effects of moisture content.
  - If you use FORM-G (EMISSIONS ESTIMATING FORM) to calculate emissions from this source, do NOT calculate emissions on this form because it will cause double counting of the emissions.

SCC codes: listed in Table 2 of this packet.

PM_{10} Emissions Estimation Table:

- The first line in the emissions calculation table is an example.

Overall Control Efficiency:

- Controls for fugitive sources can include enclosing sources and watering (or wet suppression during handling).
- If there are no control devices used, then put a "0" in the table.
- If one control device is used, then enter the percentage (%) control efficiency in the table.
- If two or more control devices are used, then the overall control efficiency must be calculated as follows: (Attach calculations on a separate page.)

$$CE = CE_1 + \left[(100 - CE_1) \times \frac{CE_2}{100}\right]$$

Where: CE = Overall control efficiency (%)
CE_1 = Control efficiency of device #1 (%)
CE_2 = Control efficiency of device #2 (%)

Example: An emissions unit is controlled with two devices. The first control device has a control efficiency equal to 35% and the second control device has a control efficiency equal to 40%. The overall control efficiency is equal to: 35 + [(100-35) × 0.40] = 35 + 26 = 61%.

Emissions:

- Calculate emissions using the following formula:

$$\text{Emissions (pounds/year)} = 0.0054 \times Q \times D \times \left(\frac{1}{M}\right)^{1.4} \times \left(1 - \frac{C}{100}\right)$$

Where: Q = Quantity transferred (tons/day)
D = Days per year operating (day)
M = Percent moisture content of material (%)
C = Overall control efficiency (%)

- Make sure that units are consistent throughout the equation (i.e., do not mix pounds and tons).
- Emissions must be recorded as pounds per year.

Moisture Content: Provide information about where you obtained the moisture content data.

FORM-H2: FUGITIVE DUST EMISSIONS - STORAGE PILES

- Use THIS form OR FORM-G if you have any type of transfer or conveying operations at your facility.
  - Use this form if you want to estimate the emissions for this source with an emission factor that reflects the silt content.
  - Use the FORM-G (EMISSIONS ESTIMATING FORM) if you want to estimate the emissions from this source using an AP-42 or Table 2 of this packet, which do NOT reflect silt content.
  - If you use FORM-G (EMISSIONS ESTIMATING FORM) to calculate emissions from this source, do NOT calculate emissions on this form because it will cause double counting of the emissions.
  - This form is to be used for a continuously active storage pile (i.e., the pile is disturbed often by loading/unloading operations). If the storage pile is not disturbed often, you may want to use the emission estimating methodology provided in Chapter 13.2.4 of EPA's *Compilation of Emission Factors* (or AP-42). If you choose this alternate method, complete the top half of this form and attach the calculations.

SCC codes: listed in Table 2 of this packet.

PM_{10} Emissions Estimation Table:

- The first line in the emissions calculation table is an example.

Overall Control Efficiency:

- Controls for fugitive sources can include enclosing sources and watering (or wet suppression). Typical control efficiencies for storage piles are shown below.

Fugitive Control	Typical Control Efficiency
Storage Area Totally Enclosed	95%
Wind Fence	60%
Wet Suppression (Regular watering)	50%

- If there are no control devices used, then put a "0" in the table.
- If one control device is used, then enter the percentage (%) control efficiency in the table.
- If two or more control devices are used, then the overall control efficiency must be calculated as follows: (Attach calculations on a separate page.)

$$CE = CE_1 + \left[(100 - CE_1) \times \frac{CE_2}{100} \right]$$

Where: CE = Overall control efficiency (%)
CE_1 = Control efficiency of device #1 (%)
CE_2 = Control efficiency of device #2 (%)

Example: An emissions unit is controlled with two devices. The first control device has a control efficiency equal to 35% and the second control device has a control efficiency equal to 0.40%. The overall control efficiency is equal to: 35 + [(100-35) × 0.40] = 35 + 26 = 61%.

Emissions:
- Calculate emissions using the following formula:

$$\text{Emissions (pounds/year)} = 1.214 \times A \times N \times s \times \left(1 - \frac{C}{100} \right)$$

Where: A = Storage pile area (acres)
N = Number of days per year the pile is disturbed (days)
s = Percent silt content of material (%)
C = Overall control efficiency (%)

- Make sure that units are consistent throughout the equation (i.e., do not mix pounds and tons).
- Emissions must be recorded as pounds per year.

Silt Content: Provide information about where you obtained the silt content data.

FORM H-3: FUGITIVE DUST EMISSIONS - UNPAVED INDUSTRIAL ROAD EMISSIONS

- Use this form OR FORM-G if you have any type of unpaved road at your facility.
  - Use THIS form if you want to estimate the emissions for this source with an emission factor that reflects the effects of moisture content.
  - Use FORM-G (EMISSIONS ESTIMATING FORM) if you want to estimate the emissions from this source using an emission factor from AP-42 or Table 2 of this packet.
  - If you use FORM-G (EMISSIONS ESTIMATING FORM) to calculate emissions from this source, do NOT calculate emissions on this form because it will cause double counting of the emissions.

SCC codes: listed in Table 2 of this packet.

PM_{10} Emissions Estimation Table:

- The first line in the emissions calculation table is an example.

Vehicle Type: Group vehicles that typically use facility roads into the following types: heavy duty trucks, light duty trucks and passenger vehicles. You may create additional types if warranted. Avoid listing each vehicle separately.

Average Distance per Round Trip: Only include miles traveled on roads on the facility property. Do not include miles traveled by vehicles off-site.

Overall Control Efficiency:

- Dust suppresants for unpaved roads can include watering or petroleum resins. See Chapter 13.2.2 of AP-42 for ways to estimate control efficiency for various suppressants.
- If there are no controls used, then put a "0" in the table.
- If controls are used, then enter the percentage (%) control efficiency in the table

Emissions:

- Calculate emissions using the following formula:

$$\text{Emissions (pounds/year)} = 0.0074 \times \frac{s^{0.8} \times W^{0.4}}{M^{0.3}} \times S \times d \times T \times D \times \left(1 - \frac{C}{100}\right)$$

Where:
s = Silt content of unpaved road (%)
W = Average vehicle weight (tons)
M = Surface material moisture content (%)
S = Average vehicle speed (mph)
d = Days per year that vehicle activity occurs on road (days)
T = Number of round trips made on road per day (no unit)
D = Average distance per round trip (miles)
C = Overall control efficiency (%)

- Make sure that units are consistent throughout the equation (i.e., do not mix pounds and tons).
- Emissions must be recorded as pounds per year.

Silt Content: Provide information about where you obtained the silt content data.

FORM H-4: FUGITIVE DUST EMISSIONS - PAVED INDUSTRIAL ROAD EMISSIONS

- Use this form OR FORM-G if you have any type of paved road at your facility.
  - Use THIS form if you want to estimate the emissions for this source with an emission factor that reflects the effects of moisture content.
  - Use FORM-G (EMISSIONS ESTIMATING FORM) if you want to estimate the emissions from this source using an AP-42 or Table 2 of this packet.
  - If you use FORM-G (EMISSIONS ESTIMATING FORM) to calculate emissions from this source, do NOT calculate emissions on this form because it will cause double counting of the emissions.

SCC codes: listed in Table 2 of this packet.

PM$_{10}$ Emissions Estimation Table:
- The first line in the emissions calculation table is an example.

Vehicle Type: Group vehicles that typically use facility roads into the following types: heavy duty trucks, light duty trucks and passenger vehicles. You may create additional types if warranted. Avoid listing each vehicle separately.

Road Surface Silt Loading: Site-specific silt loading data should be used if possible. Silt loading is defined as the mass of silt-sized material (i.e., material less than 75 micrometers in physical diameter) per unit area of travel surface. Default silt loading values are presented in AP-42.

Average Distance per Round Trip: Only include miles traveled on roads on the facility property. Do not include miles traveled by vehicles off-site.

Overall Control Efficiency:
- Controls for paved roadways include a program of regular street sweeping is effective in the removal of dust. A typical control efficiency for street sweeping of paved roadways is 34%.
- If there are no controls used, then put a "0" in the table.
- If controls are used, then enter the percentage (%) control efficiency in the table.

Emissions:
- Calculate emissions using the following formula:

$$\text{Emissions (pounds/year)} = 0.002 \times L^{0.65} \times W^{1.5} \times D \times T \times d \times \left(1 - \frac{C}{100}\right)$$

Where: L = Road surface silt loading (g/m^2)
W = Average vehicle weight (tons)
D = Average distance per round trip (miles)
T = Number of round trips made on road per day (unitless)
d = Days per year that vehicle activity occurs on road (days)
C = Overall control efficiency (%)

- Make sure that units are consistent throughout the equation (i.e., do not mix pounds and tons).
- Emissions must be recorded as pounds per year.

Silt Loading: Provide information about where you obtained the silt loading data.

FORM-VOC: EVAPORATIVE VOC EMISSIONS

REQUIRED FOR ALL FACILITIES
- Use this form if you use any type of VOC-containing material at your facility.
  - Complete only ONE Form-VOC for the facility. Include ALL types of VOC-containing material used at the facility, including surface coating, degreasing, clean-up solvents, and miscellaneous solvents.
  - VOC emissions from combustion sources will be estimated with FORM-B; VOC emissions from process stacks will be estimated with FORM-G.

Material Type: General information about solvent-containing material (e.g., primer, cold-cleaning solvent, etc.).

Annual Material Disposed: List the quantity of material wasted, recycled, or otherwise removed from the process.

Solvent Name: List specific VOC solvent in solvent-containing material (e.g., toluene, xylene, benzene, etc.).

VOC Emissions:

- Calculate emissions using the following formula:

$$\text{Emissions (pounds/year)} = (U - D) \times S \times \frac{d}{100}$$

Where:			
	U	=	Annual usage (gallons/year)
	D	=	Annual disposal (gallons/year)
	S	=	Solvent content (vol%)
	D	=	Density (pounds/gallon)

- Emissions must be recorded as pounds per year.
- Make sure that units are consistent throughout the equation.

FORM-EPISODE: DAILY AND HOURLY OPERATION SCHEDULE DURING DECEMBER 20-26, 1999

REQUIRED FOR ALL FACILITIES

Daily Hours of Operation: Record the number of hours of operation for each item with an ID Number during the week of Monday, December 20 through Sunday, December 26, 1999.

Abnormal Conditions: If any type of abnormal operating condition occurred during this week, please list the day and hour, and explain the nature of the condition. For example, if Source FF-1 (Fabric Filter #1) was off-line for 1 hour, then the time, duration and nature of the condition should be described in this column.

CEM Data: If the source's emissions are monitored by a continuous emissions monitor (CEM), place a check in this column and attach a print-out of the emissions emitted by the source, for each hour of each day (12/20-12/26).

FORM-SUM: EMISSIONS SUMMARY

REQUIRED FOR ALL FACILITIES

- This is a two-page form.

Page One

Annual Emissions:

- Summarize the 1999 emissions for each source and pollutant based on the information recorded on the other forms in this packet.

- Emissions must be recorded as pounds per year.

Grand Total:
- Sum the emissions for each column.
- Emissions must be recorded as pounds per year.

Page Two
Maximum Potential Emissions:
- Every source listed on Page One of this form should also be included on Page Two.
- Sources that have been added since 1999 should be assigned a new ID Number.
- Sources that have been shut down since 1999 should be assigned zero emissions.
- Follow these procedures for each pollutant type and each source:

Basis:
- For each source and pollutant, check the "Permitted" box if emissions are limited by an air quality permit; check the "Maximum" box if emissions are not limited by an air quality permit.

Emissions:
- If emissions are limited by an air quality permit (i.e., the "Permitted" box is checked), then enter the maximum emissions allowed by the permit.
- If emissions are not limited by an air quality permit (i.e., the "Maximum" box is checked), then calculate maximum emissions using the following guidelines:
  - Maximum potential emissions are the emissions that could be emitted if the source was operating at maximum capacity. In general, maximum capacity is assumed to be 24 hours per day, 365 days per year at maximum throughput. (One exception to this is maximum possible emissions from emergency diesel generators, which are assumed to run 500 hours per year.)
  - For each source listed, attach documentation of maximum emission calculations and supporting assumptions. The same calculation methods used to calculate 1999 emissions should be used to estimate maximum emissions. Maximum activity data should be used instead of typical activity data used to estimate 1999 emissions.
- Record emissions in units of pounds per year.

Grand Total:
- Sum the emissions for each column.
- Emissions must be recorded as pounds per year.

BLANK EMISSIONS INVENTORY FORMS

INDUSTRIAL POINT SOURCE QUESTIONNAIRE

Inventory Checklist

☐ **Facility Information (FORM-A)**

  ☐ **Facility Plot Plan (for facilities with 1999 annual emissions greater than 25 tons of PM_{10} or 100 tons of NO_x, SO_x, VOC, or NH_3).**

☐ **Combustion Equipment Information Form (FORM-B)**

Number of Sources (or forms included): _________

☐ **Materials Transport, Handling, Storage Information Form (FORM-C)**

Number of Sources (or forms included): _________

☐ **General Emission Source Information Form (FORM-D)**

Number of Sources (or forms included): _________

☐ **Stack Information Form (FORM-E)**

Number of Stacks included in Inventory: _________

☐ **Emissions Controls Information Form (FORM-F)**

Number of Controls included in Inventory: _________

☐ **Emissions Estimating Form (FORM-G) – Emission Factors**

☐ **Fugitive Dust Emissions Form (FORM-H1) – Transfer, Conveying Operations**

☐ **Fugitive Dust Emissions Form (FORM-H2) – Storage Pile Emissions**

☐ **Fugitive Dust Emissions Form (FORM-H3) – Unpaved Industrial Road Emissions**

☐ **Fugitive Dust Emissions Form (FORM-H4) – Paved Industrial Road Emissions**

☐ **Evaporative VOC Emissions Form (FORM-VOC) – VOC Emissions from Solvents, Degreasing, Surface Coating, Etc.**

☐ **December 20-26, 1999, Episode Form (FORM-EPISODE) – Hourly and Daily Operating Schedule During December 1999 Episode**

☐ **Emissions Summary (FORM-SUM)**

Facility Information (FORM-A)

Facility Name: ______________________________

Facility Street Address, City, Zip Code (Physical Location): ______________________________

____

____

Mailing Address, City, State Zip Code (if different than above): ______________________________

____

____

Contact Name: ______________________________

Title: ______________________________

Telephone Number: (   )   -

Short Description of Business: ______________________________

____

SIC Code: ______________________________

Facility Location Coordinates:

UTM Easting (Km) ☐☐☐☐ . ☐☐☐

UTM Northing(Km) ☐☐☐☐ . ☐☐☐

If coordinates are not for center of facility, then specify location of coordinates: ______________________________

____

Facility County (Check Box) ☐ Ada ☐ Canyon

Is the facility registered as a portable facility? ☐ Yes ☐ No

Air Permit Number (if facility does not have one, enter "none")**:** ______________________________

Emission Sources	Brief Description of Operated Process that Generates Emissions	ID Number

Facility Information – Continued (FORM-A)

Description of Process Flow of the Facility:

If your facility's 1999 annual emissions are greater than 25 tons of PM_{10} or 100 tons of NO_x, SO_x, VOCs, or NH_3, attach a plot plan and process flow diagram as described below:

- Facility Plot Plan:
  - — To scale (with reference point marked on plan in UTM coordinates or latitude/longitude).
  - — Indicate emission sources (specify Stacks and Source ID).
  - — Indicate building dimensions (including building heights) on the plot plan.
- Process Flow Diagram:
  - — Specify Source, Stack, and ID Number on diagram.

Combustion Equipment Information (FORM-B)

Facility Name ____________________

ID Number ☐☐☐☐☐☐

Equipment Name: ____________________

Equipment Description: ____________________

Manufacturer Name and Model Number: ____________________

Equipment Type (Please Check the Appropriate Box)

External Combustion Equipment

☐ Boiler ☐ Heater ☐ Incinerator

☐ Kiln ☐ Furnace ☐ Other - Specify __________

Internal Combustion Equipment

☐ Reciprocating Engine

☐ Turbine Combined Cycle ☐ Turbine Single Cycle

Combustion Equipment Fuel (Please Check the Appropriate Box)

☐ Natural Gas ☐ Diesel Fuel ☐ Propane

☐ Gasoline ☐ Fuel Oil (Fuel Oil #6) ☐ Coal

☐ Waste Wood ☐ Other – Specify

Equipment/Fuel Information		***Check Appropriate Units***
Size or Rated Capacity:	__________	☐ Million BTU/Hr ☐ Horsepower
Maximum Annual Fuel Usage:	__________	☐ Million Ft^3/Yr ☐ 1,000 Gal/Yr ☐ Tons/Yr
1999 Annual Fuel Usage:	__________	☐ Million Ft^3/Yr ☐ 1,000 Gal/Yr ☐ Tons/Yr

Sulfur Content of Fuel __________ % Sulfur

Ash Content __________ % Ash

Fuel Heat Content __________ ☐ BTU/Ft^3 ☐ BTU/lb ☐ BTU/Gal

Further Instructions:

1. **You must also estimate the emissions for the source described above using FORM-G.**
2. **If emissions from the above equipment are controlled, you must also complete the Control Device Form (FORM-F).**
3. **Complete the Stack Form (FORM-E) for each piece of combustion equipment for which emissions are released to the atmosphere through a stack.**

Materials Transport, Handling, Storage Information (FORM-C)

Facility Name ______________________________

ID Number ☐☐☐☐☐☐

Equipment/Operation Name: ______________________________

Equipment/Operation Description: ______________________________

____

____

____

Manufacturer Name (if applicable): ______________________________

Model Number (if applicable): ______________________________

Operation Type (Please Check the Appropriate Box)

☐ Belt Conveyor

Enclosed?	☐ Yes	☐ No
Covered?	☐ Yes	☐ No
Inside Building?	☐ Yes	☐ No

☐ Pneumatic Conveyor

☐ Storage Pile

☐ Storage Silo

Material Transfer Rates (If not applicable, enter N/A)

Maximum Hourly Transfer Rate: ________ Tons/hour

Normal Hourly Transfer Rate: ________ Tons/hour

Typical Annual Transfer Rate: ________ Tons/year

Storage Capacity (If not applicable, enter N/A)

Maximum Storage Capacity: __________ Tons

Maximum Pile Length: __________ Feet

Maximum Pile Width __________ Feet

Maximum Pile Height: __________ Feet

Further Instructions:

1. **You must also estimate the emissions for the source described above using either FORM-G or FORM-H.**
2. **If the emissions from the above equipment are controlled, you must also complete the Control Device Form (FORM-F).**

General Emission Source Information (FORM-D)

Facility Name ____

ID Number | | | | | | |

Operation/Equipment Name: __________________________________

Operation/Equipment Description: ______________________________

Manufacturer Name: ______________________________________

Model Number: ____

Production Rates (If not applicable, enter N/A)

Maximum Hourly Production Rate:	________	Units	____________
Normal Hourly Production Rate:	________	Units	____________
Typical Annual Production Rate:	________	Units	____________

Further Instructions:

1. **You must also estimate the emissions for the source described above using FORM-G.**
2. **If emissions from the above equipment are controlled, you must also complete the Control Device Form (FORM-F).**
3. **Complete the Stack Form (FORM-E) for each piece of equipment for which emissions are released to the atmosphere through a stack.**

Stack Information (FORM-E)

Facility Name ____

ID Number | | | | | | | |

Stack Parameters:

Stack Height	_________	Feet
Inside Stack Diameter	_________	Feet
Exit Gas Temperature	_________	Degrees Fahrenheit
Exit GasVelocity	_________	Feet/second

Stack Location Coordinates (Provide the location of each stack in the facility)

UTM Easting (Km) | | | | | . | | | |

UTM Northing(Km) | | | | | . | | | |

Emissions Controls Information (FORM-F)

Facility Name ______________________________

ID Number [| | | | |]

Control Code (See Table 1) [| |]

Description: ______________________________

____

____

Pollutants Controlled, Control Efficiency

✓	%	*CER Code(s)*	*Comments/Explanation*
☐ PM_{10}			
☐ NO_x			
☐ SO_x			
☐ VOC			
☐ CO			
☐ NH_3			

Control Efficiency Reference Codes

1 = Tested Efficiency/EPA Reference Method	4 = EPA AP-42 Document
2 = Design Value Provided by Manufacturer	5 = Estimated Based on Other Published Value
3 = Best Guess/ Engineering Estimate	

Emissions Estimating (FORM-G) - Emission Factors

Facility: ______________________

SCC Code ☐☐☐☐☐☐☐☐☐

ID Number: ☐☐☐☐☐☐

Source Type:
- ☐ Combustion Equipment
- ☐ Materials Transport, Handling, Storage
- ☐ Stack Emissions
- ☐ Fugitive Source
- ☐ General Source

Emissions Controls On This Source *(Submit FORM-F for each control)***:**

ID Number: ☐☐☐☐☐ ID Number: ☐☐☐☐

ID Number: ☐☐☐☐☐ ID Number: ☐☐☐☐

1999 Operating Schedule

Percentage Throughput in Each Season (*Sum of the throughput must equal 100%):*

Dec-Feb _______ Mar-May _______ Jun-Aug _______ Sep-Nov _______

Normal Weekday Operation (Monday-Friday):

Hours/Day _______ No. of Days (1-5): _______ Start Time (Military Time) _______

Normal Weekend Operation (Saturday-Sunday):

Hours/Day _______ No. of Days (1-2): _______ Start Time (Military Time) _______

Emissions Estimation

1999 Activity Level: _______ **Units:** ☐ 1,000 Gal ☐ Ton ☐ Million Ft^3 ☐ 1,000 lb ☐ Acre ☐ Other _______

	Emission Factors			**Overall Control**	**Emissions**
Pollutant	**Value**	**Units**	**EF Code**	**Efficiency** (%)	(Pounds per Year)
PM_{10}					
NO_x					
SO_x					
VOC					
CO					
NH_3					

Specify detailed reference for emission factors _______________________

Emissions Factor Codes

1 = Source Test Measurements
2 = Continuous Emissions Monitoring
3 = Best Guess/ Engineering Estimate
4 = Material Balance
5 = EPA AP-42
6 = FIRE Emission Factor from Table 2
7 = State or Local Emission Factor

Fugitive Dust Emissions (FORM-H1)
Transfer, Conveying Operations

Facility: ______________________

ID Number: [ ][ ][ ][ ][ ][ ]

SCC Code (See Table 2) [ ][ ][ ][ ][ ][ ][ ][ ]

Emissions Control On This Source *(Submit FORM-F for each control):*

ID Number: [ ][ ][ ][ ][ ]   ID Number: [ ][ ][ ][ ][ ]

ID Number: [ ][ ][ ][ ][ ]   ID Number: [ ][ ][ ][ ][ ]

1999 Operating Schedule

Percentage Throughput in Each Season (*Sum of the throughput must equal 100%):*

Dec-Feb ______ Mar-May ______ Jun-Aug ______ Sep-Nov ______

Normal Weekday Operation (Monday-Friday):

Hours/Day ______ No. of Days (1-5): ______ Start Time (Military Time) ______

Normal Weekend Operation (Saturday-Sunday):

Hours/Day ______ No. of Days (1-2): ______ Start Time (Military Time) ______

PM_{10} Emission Estimation

Material	**Location From**	**Location To**	**Transfer Method**	**Quantity Transferred** (Tons/Day) **(Q)**	**Days Per Year Operating (D)**	**Percent Moisture Content of Transferred Material (M)**	**Percent Overall Control Efficiency (C)**	**Emissions (pounds/year)**
Waste Rock	*Quarry*	*Waste Rock Pile*	*Truck*	*960*	*208*	*2.0*	*0*	*409*

Provide reference for moisture content provided above:______________________

Fugitive Dust Emissions (FORM-H2)
Storage Pile Emissions

Facility: ______________________________

ID Number: | | | | | | |

SCC Code (See Table 2) | | | | | | | | |

Emissions Control On This Source *(Submit FORM-F for each control):*

ID Number: | | | | | | ID Number: | | | | | |

ID Number: | | | | | | ID Number: | | | | | |

1999 Operating Schedule

Percentage Throughput in Each Season (*Sum of the throughput must equal 100%):*

Dec-Feb _______ Mar-May _______ Jun-Aug _______ Sep-Nov _______

Normal Weekday Operation (Monday-Friday):

Hours/Day _________ No. of Days (1-5): ________ Start Time (Military Time) ________

Normal Weekend Operation (Saturday-Sunday):

Hours/Day _________ No. of Days (1-2): ________ Start Time (Military Time) ________

PM_{10} Emission Estimation

Material Type	Storage Pile Area in Acres (A)	Number of Days Per Year the Pile is Disturbed (N)	Percent Silt Content of Pile Material (s)	Percent Overall Control Efficiency (C)	Emissions (pounds/year)
Waste Rock Pile	*5*	*208*	*2*	*0*	*2,525*

Provide reference for silt content provided above: ______________________________

Fugitive Dust Emissions (FORM-H3) – Unpaved Industrial Road Emissions

Facility: ______________________

ID Number: [ ][ ][ ][ ][ ][ ]

SCC Code (See Table 2) [ ][ ][ ][ ][ ][ ][ ][ ]

Emissions Control On This Source *(Submit FORM-F for each control):*

ID Number: [ ][ ][ ][ ][ ] ID Number: [ ][ ][ ][ ][ ]

ID Number: [ ][ ][ ][ ][ ] ID Number: [ ][ ][ ][ ][ ]

1999 Operating Schedule

Percentage Throughput in Each Season (*Sum of the throughput must equal 100%):*

Dec-Feb ______ Mar-May ______ Jun-Aug ______ Sep-Nov ______

Normal Weekday Operation (Monday-Friday):

Hours/Day ______ No. of Days (1-5): ______ Start Time (Military Time) ______

Normal Weekend Operation (Saturday-Sunday):

Hours/Day ______ No. of Days (1-2): ______ Start Time (Military Time) ______

PM_{10} Emission Estimation

Vehicle Type	**Percent Silt Content of Unpaved Road (s)**	**Average Vehicle Speed** (mph) **(S)**	**Average Vehicle Weight** (Tons) **(W)**	**Percent Surface Material Moisture Content (M)**	**Days per year vehicle activity occurs on road (d)**	**Number of Round Trips Per Day (T)**	**Average Distance per Round Trip** (miles) **(D)**	**Percent Overall Control Efficiency (C)**	**Emissions (pounds/year)**
Dump	4.8	10	20	3	250	6	1	0	928
								Total (sum for all vehicle types)	

Provide references for silt content provided above:______________________

Fugitive Dust Emissions (FORM-H4) - Paved Industrial Road Emissions

Facility: ______________________________

ID Number: | | | | | | |

SCC Code (See Table 2) | | | | | | | | |

Emissions Control On This Source *(Submit FORM-F for each control):*

ID Number: | | | | | |　　ID Number: | | | | | |

ID Number: | | | | | |　　ID Number: | | | | | |

1999 Operating Schedule

Percentage Throughput in Each Season (*Sum of the throughput must equal 100%):*

Dec-Feb _______ Mar-May _______ Jun-Aug _______ Sep-Nov _______

Normal Weekday Operation (Monday-Friday):

Hours/Day _________ No. of Days (1-5): _______ Start Time (Military Time) ________

Normal Weekend Operation (Saturday-Sunday):

Hours/Day _________ No. of Days (1-2): ________ Start Time (Military Time) ________

PM_{10} Emission Estimation

Vehicle Type	**Road Surface Silt Loading** (g/m^2)**(L)**	**Mean Vehicle Weight** (Tons) **(W)**	**Average Number of Round Trips Per Day (T)**	**Average Distance per Round Trip** (miles) **(D)**	**Days per year vehicle activity occurs on road (d)**	**Percent Overall Control Efficiency (C)**	**Emissions (pounds/year)**
Dump Trucks	70	20	6	2	250	0	8,492
						Total (sum for all vehicle types)	

Provide reference for silt loading provided above: ______________________________

Evaporative VOC Emissions (FORM-VOC)

Facility: ______________________________

ID Number: | | | | | | |

Material Type	**Annual Material Usage** (gal/yr)	**Annual Material Disposed** (gal/yr)	**Solvent Name**	**Solvent Content** (vol%)	**Solvent Density** (lb/gal)	**VOC Emissions** (lbs/yr)

December 20-26, 1999, Episode (FORM-EPISODE)

Facility: ______________________________

	Daily Hours of Operation (1999)								
ID Number	**MON 12/20**	**TUES 12/21**	**WED 12/22**	**THU 12/23**	**FRI 12/24**	**SAT 12/25**	**SUN 12/26**	**Describe Any Abnormal Conditions**	**Indicate Available CEMs Data**

Emissions Summary (FORM-SUM)

Facility: ______________________________

							1999 Annual Emissions (Pounds/Year)					
ID Number							**PM_{10}**	**NO_x**	**SO_x**	**VOC**	**CO**	**NH_3**
Grand Total												

Emissions Summary – Continued (FORM-SUM)

Maximum Potential Emissions (Pounds per Year)												
	PM_{10}		NO_x		SO_x		VOC		CO		NH_3	
ID Number	**Emissions**	**Basis**	**Emissions**	**Basis**	**Emissions**	**Basis**	**Emissions**	**Basis**	**Emissions**	**Basis**	**Emissions**	**Basis**
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum		❏ Permitted ❏ Maximum
Grand Total												

APPENDIX A-3
POINT SOURCE QUESTIONNAIRE QA/QC CHECKLIST

<u>UPON RECEIPT OF PSQ FROM DEQ:</u>

1. Check name of facility on master list and write facility ID number on PSQ for facilities that participated in 1995 inventory (use same ID number).
2. Indicate reason if facility should not be included in 1999 inventory:
   - Category I – Not a PM10 precursor source (e.g., corporate office, distribution center)
   - Category II – Negligible emissions (e.g., PM10 potential <<1 ton/year), and send message to Marty to include in area source inventory if appropriate
   - Category III – Does not exist (e.g., out of business in 1999)
   - Category IV – Out of inventory domain (i.e., not located in either Ada or Canyon County)

Action: Continue to "initial completeness checks" for facilities to be included in 1999 EI.

<u>INITIAL COMPLETENESS CHECKS:</u>

1. Missing forms: EPISODE, SUM, Form A
2. Missing pollutants: spot check pollutant lbs/year to sample of PSQ forms
3. Missing NH3 emissions on FORM G if yes on FORM B
   Missing PM10/NO_x on FORM G if "yes" on FORM B.
4. Missing data in required fields (ENVIRON's e-mail):
   - UTMs, only portable plants should have no UTMs; or out of range UTMs (498-583, 4785-4850 km)
   - SICs
5. Illegible writing
6. Questionable control efficiencies, references
7. Questionable emission factors, references, units
8. Missing or inadequate process descriptions

Action:Call facility to provide missing or incorrect data.

<u>DETAILED PSQ CHECKS:</u>

1. ALL ACTIVITY DATA: If units are different than one of the selections (e.g., Form B- size or rated capacity has a value with the words million ft3/hr scribbled by it), then convert to one of the set of units available (e.g., MMBTU/hr or horsepower) and change the form accordingly. All of the data necessary to convert any values should be either on the form or in the unit conversion table.

2. Form C: Create "other/specify" if one of the options is not selected and for specify fill in generic equipment name/operation (e.g., loader, hauling, etc.).

3. Form D, the hourly rates should be in units per hour and the annual rate should be in units per year.

4. Form E: Make sure that all stack parameters are there. Check that they haven't tried to give us the stack height in inches or the flowrate instead of the velocity. If they do this, then I'll

just calculate them in the correct units. In the beginning I was flagging missing stack UTMs but as this became more common, I realized that we could flag these easily in the database and insert the facility locations if they did not give us stack UTMs.

5. Form F: Control code should match the control description (using Table 1 from the PSQ).

6. Form G: Be sure that only one source type is selected. If the source has a stack, then the stack emissions must be the only one checked off and the stack ID should be identified somewhere in the source type box (so Lilian can see it clearly and enter it in the stack ID field of the database).

7. Form G: Should have value for denominator only, e.g., MMBtu, not lb/MMBtu. Correct with 1 set of units.

8. Froms G and H: The 1999 operating schedule for percentage throughput should add up to 100%. Also, the weekend and weekday operation schedules should make sense (i.e., no 26 hour days).

9. Forms G and H: The 1999 activity level should be similar or match the annual activity in Forms B, C, or D.

10. Forms G and H: If a control efficiency is used to calculate emissions in Form G or Form Hs, then it should be in the table, but if a controlled emission factor is used, then cross out the control efficiency and make note of a controlled emission factor. Along the same lines, the control ID should always be entered in (even if a controlled emission factor is used) and if the control efficiency is used to calculate emissions then the control efficiency in Form-G or Form Hs needs to match Form F for that specific control.

11. Last Steps:
    - All Forms: Mark through extraneous comments, etc.
    - Contact DEQ and facility when significant changes are made (e.g., emissions greater than a factor of 10 higher/lower than estimated by facility)
    - Put forms in order by form (i.e., All Form "A"s together, etc.) and give to clerk for data entry.

APPENDIX A-4
DATABASE QA/QC CHECKLIST

Fix error or call facility to resolve problem, missing data.

1. Query: Stack IDs without Sources. Fill in correct stack ID on Form G, etc.

2. Query: Compare total of entries on Form SUM to total of entries on Forms G, H, and VOC by pollutant

3. Facility level checks by pollutant:
    a. Compare magnitude of 1999 annual emissions to 1995 emissions
    b. Compare facilities by SIC. Summarize by SIC number and compare descriptions of activity.

4. All sources with PTE: quantities must be >0. All sources should be accounted for.

Appendix B
Area Sources

Fuel Distributor Survey Form

Fuel Sales Data Collection Survey – Propane

Company Name:____
Address:____
Phone Number:_______________________ Fax Number:______________________
Contact Name:__________________________Signature:______________________
Date:_____________________________

Ada County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Canyon County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Fuel Sales Data Collection Survey – Natural Gas

Company Name:____
Address:____
Phone Number:________________________ Fax Number:_______________________
Contact Name:____________________________Signature:_______________________
Date:______________________________

Ada County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Canyon County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Fuel Sales Data Collection Survey – Coal

Company Name:____
Address:____
Phone Number:_______________________ Fax Number:______________________
Contact Name:__________________________Signature:______________________
Date:_____________________________

Ada County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Canyon County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Fuel Sales Data Collection Survey – #1 Diesel

Company Name:____
Address:____
Phone Number:_________________________ Fax Number:________________________
Contact Name:_____________________________Signature:________________________
Date:________________________________

Ada County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Canyon County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Fuel Sales Data Collection Survey – #2 Diesel

Company Name:____
Address:____
Phone Number:________________________ Fax Number:________________________
Contact Name:____________________________Signature:________________________
Date:______________________________

Ada County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Canyon County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Fuel Sales Data Collection Survey – Heating Oil

Company Name:____
Address:____
Phone Number:_______________________ Fax Number:______________________
Contact Name:__________________________Signature:______________________
Date:_____________________________

Ada County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Canyon County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Fuel Sales Data Collection Survey – Wood (Firewood/Pellets)

Company Name:____
Address:____
Phone Number:______________________ Fax Number:_____________________
Contact Name:_________________________Signature:_____________________
Date:___________________________

Ada County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Canyon County

Period	**Sales Unit**	**Industrial**	**Comm./Instit.**	**Residential**
January 1999				
February 1999				
March 1999				
April 1999				
May 1999				
June 1999				
July 1999				
August 1999				
September 1999				
October 1999				
November 1999				
December 1999				
Total 1999				
Total 1996				
Total 1997				
Total 1998				
Total 2000				

Do you know if any of the fuels that you have sold within Ada and/or Canyon County are consumed outside of those two counties? If so, please explain:_____________________

____

____

Who are your most significant industrial customers?:______________________________

____

Who are your most significant commercial and/or institutional customers?:___________

____

If there were significant increases or decreases in the quantity of annual fuel sales during the period between 1996 and 2000, what were the primary reasons?:_________________

____

The initial mailing of this fuel sales survey was sent to the following fuel distributors:

1st Propane of Boise	Gran-Del Petroleum Products	Thermo Fluids Inc.
All Star Gas Inc	Holloway Tree Service	Tiller Fuel & Lumber Co.
American Energy (Meridian, Boise)	IGI Resources Inc.	Timberline Tree Service
American Petroleum Inc.	Intermountain Gas Company	U-Haul (Boise, Nampa)
American Tree Service	Kelly’s Sinclair Service	United Oil
B & W Fuels Inc.	Meyers Home Service	V-1 Propane
Baird Oil	Moore Tree Service	Webb Oil
Bob Nicholes Oil	Public Firewood Cutting	Woody’s Tree Service
Brico of Idaho	Qualitree	Zamzows (Boise, Nampa, Meridian, Kuna, Eagle)
Cahill Oil	Robison Logging & Excavation	
Cenex Propane	Sawtooth Forest Industries	
Champion Oil	Steve’s Tree Service & Firewood	
Chevron Pipe Line Co.	Stockdale Tree	
Ernst Fuel	Suburban Propane	
Franklin United Oil	T K Oil	
Fuel West Company	T S Fuel	
Gem Supply Cooperative	Tates Rents	
Goodman Oil (Boise, Marsing, Homedale, Grand View)	Terry’s Tree Service	

Are you aware of other fuel distributors located inside of Ada or Canyon County that we have not identified? If so, please provide information:_____________________________

____

Are you aware of other fuel distributors located outside of Ada or Canyon County that sell fuel to customers located inside Ada or Canyon County? If so, please provide information:____

____

Appendix C
Mobile Sources

1999 MOBILE6 and PART5 input files for freeways
Input files for all other roadway types are the same except for average speed

```
MOBILE6 INPUT FILE :
>
>  MOBILE6 Input file generated by Route56 Translator
>  Route56 Translator Code (c) 2001 ERG  Inc.
>  9/25/01 8:39:47 AM
>
REPORT FILE        : ADAFWY99.OUT

RUN DATA           :
>
> MOBILE6 input file generated from C:\WINDOWS\Desktop\IDcon01m.inp
> FY2002-2006 TIP CONFORMITY (8/2001)
> Route56 Translator Code (c) 2001 ERG  Inc.
>
EXPRESS HC AS VOC  :
EXPAND EXHAUST     :
EXPAND EVAPORATIVE :

ANTI-TAMP PROG     :
84 81 20 22222 22222222 2 11 098. 22212112

> Exhaust I/M program 1 from MOBILE5 Exhaust I/M program #1
I/M PROGRAM        : 1 1984 2050 1 TRC IDLE
I/M MODEL YEARS    : 1 1965 2000
I/M VEHICLES       : 1 22222 22222222 2
I/M STRINGENCY     : 1 27
I/M COMPLIANCE     : 1 98
I/M WAIVER RATES   : 1 1.5 1.5

SCENARIO RECORD    : Winter 1999
CALENDAR YEAR      : 1999
EVALUATION MONTH   : 1
MIN/MAX TEMPERATURE: 31.25 48.20
FUEL RVP           : 15
AVERAGE SPEED      : 48.8 Freeway 100.0 0.0 0.0 0.0
ABSOLUTE HUMIDITY  : 26.39

SCENARIO RECORD    : Summer 1999
CALENDAR YEAR      : 1999
EVALUATION MONTH   : 7
MIN/MAX TEMPERATURE: 46.77 73.22
FUEL RVP           : 8.6
AVERAGE SPEED      : 48.8 Freeway 100.0 0.0 0.0 0.0
ABSOLUTE HUMIDITY  : 37.62

SCENARIO RECORD    : Winter 2000
CALENDAR YEAR      : 2000
EVALUATION MONTH   : 1
MIN/MAX TEMPERATURE: 31.25 48.20
FUEL RVP           : 15
AVERAGE SPEED      : 48.8 Freeway 100.0 0.0 0.0 0.0
ABSOLUTE HUMIDITY  : 26.39

END OF RUN         :
```

```
MOBILE6 INPUT FILE :
>
>  MOBILE6 Input file generated by Route56 Translator
>  Route56 Translator Code (c) 2001 ERG  Inc.
>  9/25/01 8:39:47 AM
>
REPORT FILE         : CANFWY99.OUT

RUN DATA            :
>
> MOBILE6 input file generated from C:\WINDOWS\Desktop\IDcon01m.inp
> FY2002-2006 TIP CONFORMITY (8/2001)
> Route56 Translator Code (c) 2001 ERG  Inc.
>
EXPRESS HC AS VOC  :
EXPAND EXHAUST     :
EXPAND EVAPORATIVE :

SCENARIO RECORD    : Winter 1999
CALENDAR YEAR      : 1999
EVALUATION MONTH   : 1
MIN/MAX TEMPERATURE: 31.25 48.20
FUEL RVP           : 15
AVERAGE SPEED      : 54.1 Freeway 100.0 0.0 0.0 0.0
ABSOLUTE HUMIDITY  : 26.39

SCENARIO RECORD    : Summer 1999
CALENDAR YEAR      : 1999
EVALUATION MONTH   : 7
MIN/MAX TEMPERATURE: 46.77 73.22
FUEL RVP           : 8.6
AVERAGE SPEED      : 54.1 Freeway 100.0 0.0 0.0 0.0
ABSOLUTE HUMIDITY  : 37.62

SCENARIO RECORD    : Winter 2000
CALENDAR YEAR      : 2000
EVALUATION MONTH   : 1
MIN/MAX TEMPERATURE: 31.25 48.20
FUEL RVP           : 15
AVERAGE SPEED      : 54.1 Freeway 100.0 0.0 0.0 0.0
ABSOLUTE HUMIDITY  : 26.39

END OF RUN          :
```

```
PART5 ADA COUNTY (Low, Arterial, Win Day)
3                 :VMFLAG (use MOBILE6 VMT mix)
4                 :MYMRFG (use MOBILE6 mileage accumulation rates & registration)
2                 :IMFLAG (Inspection and maintenance exists)
1                 :RFGFLG (2 to apply reformulated gasoline effects, 1 not to)
3                 :OUTFMT (indicates type of output format)
1                 :IDLFLG (2 to print idle emissions, 1 not to print them)
2                 :SO2FLG (2 to print Gaseous SO2 emissions, 1 not to print them)
1                 :PRTFLG (prints ALL pollutants)
1                 :BUSFLG (does not print alternative bus cycle emission factors)
0.4941 0.2831 0.0967 0.0357 0.0062 0.0012
:LDGV,LDGT1,LDGT2,HDGV,MC,LDDV
0.0016 0.0095 0.0060 0.0142 0.0494 0.0022
:LDDT,2BHDDV,LHDDV,MHDDV,HHDDV,BUS
 .14910 .14174 .13475 .12810 .12178 .11577 .11006 .10463 .09947 .09456 LDGV
 .08989 .08546 .08124 .07723 .07342 .06980 .06636 .06308 .05997 .05701
 .05420 .05152 .04898 .04656 .04427
 .19496 .18384 .17308 .16267 .15260 .14289 .13352 .12451 .11584 .10752 LDGT1
 .09955 .09194 .08467 .07775 .07118 .06496 .05909 .05356 .04839 .04357
 .03909 .03497 .03120 .02777 .02470
 .21331 .19865 .18500 .17228 .16044 .14942 .13915 .12959 .12068 .11239 LDGT2
 .10466 .09747 .09077 .08453 .07872 .07331 .06827 .06358 .05921 .05514
 .05135 .04782 .04454 .04148 .03863
 .20034 .18776 .17600 .16499 .15468 .14503 .13599 .12754 .11962 .11221 HDGV
 .10527 .09877 .09269 .08699 .08164 .07664 .07196 .06756 .06346 .05960
 .05599 .05261 .04944 .04647 .04369
 .04786 .04475 .04164 .03853 .03543 .03232 .02921 .02611 .02300 .01989 MC
 .01678 .01368 .01368 .01368 .01368 .01368 .01368 .01368 .01368 .01368
 .01368 .01368 .01368 .01368 .01368
 .14910 .14174 .13475 .12810 .12178 .11577 .11006 .10463 .09947 .09456 LDDV
 .08989 .08546 .08124 .07723 .07342 .06980 .06636 .06308 .05997 .05701
 .05420 .05152 .04898 .04656 .04427
 .15961 .14661 .13468 .12372 .11367 .10444 .09597 .08819 .08105 .07449 LDDT
 .06847 .06294 .05786 .05319 .04890 .04496 .04134 .03802 .03496 .03215
 .02957 .02720 .02502 .02302 .02117
 .27137 .24831 .22721 .20791 .19024 .17407 .15928 .14575 .13336 .12203 2BHDDV
 .11166 .10217 .09349 .08555 .07828 .07163 .06554 .05997 .05488 .05021
 .04595 .04204 .03847 .03520 .03221
 .31574 .28789 .26271 .23992 .21929 .20058 .18361 .16821 .15421 .14149 LHDDV
 .12991 .11937 .10975 .10098 .09298 .08567 .07898 .07286 .06726 .06213
 .05741 .05309 .04912 .04548 .04212
 .40681 .36872 .33420 .30291 .27455 .24885 .22555 .20443 .18529 .16795 MHDDV
 .15222 .13797 .12505 .11335 .10273 .09312 .08440 .07650 .06933 .06284
 .05696 .05163 .04679 .04241 .03844
1.000001.00000 .94981 .85863 .77623 .70176 .63446 .57364 .51867 .46898 HHDDV
 .42406 .38347 .34678 .31360 .28361 .25649 .23198 .20981 .18977 .17165
 .15527 .14045 .12705 .11493 .10397
 .24516 .23920 .23344 .22785 .22245 .21721 .21214 .20724 .20249 .19789 BUSES
 .19344 .18913 .18496 .18092 .17701 .17322 .16956 .16601 .16258 .15925
 .15603 .15291 .14990 .14698 .14415
 .053 .071 .071 .071 .070 .070 .069 .068 .066 .063  LDGV
 .059 .054 .046 .036 .029 .023 .018 .014 .011 .009
 .007 .006 .005 .004 .010
 .058 .077 .077 .076 .075 .072 .069 .066 .061 .056  LDGT1
 .050 .044 .037 .031 .025 .020 .015 .011 .009 .008
 .008 .008 .007 .007 .036
 .059 .074 .069 .064 .060 .056 .052 .048 .045 .042  LDGT2
 .039 .036 .034 .032 .029 .027 .025 .023 .022 .021
 .019 .018 .017 .016 .074
 .047 .086 .079 .072 .065 .056 .052 .043 .042 .037  HDGV
 .036 .035 .034 .030 .026 .024 .022 .020 .019 .022
 .021 .020 .018 .017 .077
 .144 .168 .135 .109 .088 .070 .056 .045 .036 .029  MC
 .023 .097 .000 .000 .000 .000 .000 .000 .000 .000
 .000 .000 .000 .000 .000
 .053 .071 .071 .071 .070 .070 .069 .068 .066 .063  LDDV
 .059 .054 .046 .036 .029 .023 .018 .014 .011 .009
 .007 .006 .005 .004 .010
```

```
 .058 .077 .077 .076 .075 .072 .069 .066 .061 .056  LDDT
 .050 .044 .037 .031 .025 .020 .015 .011 .009 .008
 .008 .008 .007 .007 .036
 .048 .088 .080 .073 .066 .078 .069 .082 .063 .061  2BHDDV
 .045 .035 .027 .028 .035 .032 .032 .028 .025 .001
 .000 .000 .000 .000 .000
 .055 .102 .094 .087 .080 .078 .071 .068 .061 .055  LHDDV
 .051 .045 .037 .030 .027 .020 .015 .013 .010 .001
 .000 .000 .000 .000 .001
 .047 .089 .083 .078 .073 .067 .057 .056 .050 .049  MHDDV
 .045 .037 .033 .034 .031 .029 .026 .021 .021 .022
 .016 .010 .008 .005 .014
 .039 .073 .068 .064 .059 .056 .052 .049 .046 .043  HHDDV
 .040 .037 .035 .033 .030 .029 .027 .025 .023 .022
 .020 .019 .018 .017 .080
 .049 .092 .086 .081 .077 .068 .062 .061 .063 .057  BUSES
 .052 .046 .043 .040 .035 .026 .018 .012 .011 .008
 .003 .003 .002 .002 .004
1 2000 1 15.1                : region, year, speed cycle, speed
 1.3 2.50 1                  : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                           : number of precip. days
2002 Arterial Ada Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                         : fleet average vehicle weight
1 2000 1 29.9                : region, year, speed cycle, speed
 1.3 2.50 1                  : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial Ada Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 48.8                : region, year, speed cycle, speed
 1.3 2.50 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial Ada Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 30.4                : region, year, speed cycle, speed
 1.3 2.50 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial Ada Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 32.9                : region, year, speed cycle, speed
 1.3 2.50 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial Ada Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 34.3                : region, year, speed cycle, speed
 1.3 2.50 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial Ada Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 34.9                : region, year, speed cycle, speed
 1.3 2.50 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial Ada Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
                  6000                : fleet average vehicle weight
```

```
PART5 CANYON COUNTY (Low, Arterial, Win Day)
3                :VMFLAG (use MOBILE6 VMT mix)
4                :MYMRFG (use MOBILE6 mileage accumulation rates & registration)
1                :IMFLAG (no Inspection and maintenance)
1                :RFGFLG (2 to apply reformulated gasoline effects, 1 not to)
3                :OUTFMT (indicates type of output format)
1                :IDLFLG (2 to print idle emissions, 1 not to print them)
2                :SO2FLG (2 to print Gaseous SO2 emissions, 1 not to print them)
1                :PRTFLG (prints ALL pollutants)
1                :BUSFLG (does not print alternative bus cycle emission factors)
0.4941 0.2831 0.0967 0.0357 0.0062 0.0012
:LDGV,LDGT1,LDGT2,HDGV,MC,LDDV
0.0016 0.0095 0.0060 0.0142 0.0494 0.0022
:LDDT,2BHDDV,LHDDV,MHDDV,HHDDV,BUS
 .14910 .14174 .13475 .12810 .12178 .11577 .11006 .10463 .09947 .09456 LDGV
 .08989 .08546 .08124 .07723 .07342 .06980 .06636 .06308 .05997 .05701
 .05420 .05152 .04898 .04656 .04427
 .19496 .18384 .17308 .16267 .15260 .14289 .13352 .12451 .11584 .10752 LDGT1
 .09955 .09194 .08467 .07775 .07118 .06496 .05909 .05356 .04839 .04357
 .03909 .03497 .03120 .02777 .02470
 .21331 .19865 .18500 .17228 .16044 .14942 .13915 .12959 .12068 .11239 LDGT2
 .10466 .09747 .09077 .08453 .07872 .07331 .06827 .06358 .05921 .05514
 .05135 .04782 .04454 .04148 .03863
 .20034 .18776 .17600 .16499 .15468 .14503 .13599 .12754 .11962 .11221 HDGV
 .10527 .09877 .09269 .08699 .08164 .07664 .07196 .06756 .06346 .05960
 .05599 .05261 .04944 .04647 .04369
 .04786 .04475 .04164 .03853 .03543 .03232 .02921 .02611 .02300 .01989 MC
 .01678 .01368 .01368 .01368 .01368 .01368 .01368 .01368 .01368 .01368
 .01368 .01368 .01368 .01368 .01368
 .14910 .14174 .13475 .12810 .12178 .11577 .11006 .10463 .09947 .09456 LDDV
 .08989 .08546 .08124 .07723 .07342 .06980 .06636 .06308 .05997 .05701
 .05420 .05152 .04898 .04656 .04427
 .15961 .14661 .13468 .12372 .11367 .10444 .09597 .08819 .08105 .07449 LDDT
 .06847 .06294 .05786 .05319 .04890 .04496 .04134 .03802 .03496 .03215
 .02957 .02720 .02502 .02302 .02117
 .27137 .24831 .22721 .20791 .19024 .17407 .15928 .14575 .13336 .12203 2BHDDV
 .11166 .10217 .09349 .08555 .07828 .07163 .06554 .05997 .05488 .05021
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 .31574 .28789 .26271 .23992 .21929 .20058 .18361 .16821 .15421 .14149 LHDDV
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 .40681 .36872 .33420 .30291 .27455 .24885 .22555 .20443 .18529 .16795 MHDDV
 .15222 .13797 .12505 .11335 .10273 .09312 .08440 .07650 .06933 .06284
 .05696 .05163 .04679 .04241 .03844
1.000001.00000 .94981 .85863 .77623 .70176 .63446 .57364 .51867 .46898 HHDDV
 .42406 .38347 .34678 .31360 .28361 .25649 .23198 .20981 .18977 .17165
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 .19344 .18913 .18496 .18092 .17701 .17322 .16956 .16601 .16258 .15925
 .15603 .15291 .14990 .14698 .14415
 .053 .071 .071 .071 .070 .070 .069 .068 .066 .063  LDGV
 .059 .054 .046 .036 .029 .023 .018 .014 .011 .009
 .007 .006 .005 .004 .010
 .058 .077 .077 .076 .075 .072 .069 .066 .061 .056  LDGT1
 .050 .044 .037 .031 .025 .020 .015 .011 .009 .008
 .008 .008 .007 .007 .036
 .059 .074 .069 .064 .060 .056 .052 .048 .045 .042  LDGT2
 .039 .036 .034 .032 .029 .027 .025 .023 .022 .021
 .019 .018 .017 .016 .074
 .047 .086 .079 .072 .065 .056 .052 .043 .042 .037  HDGV
 .036 .035 .034 .030 .026 .024 .022 .020 .019 .022
 .021 .020 .018 .017 .077
 .144 .168 .135 .109 .088 .070 .056 .045 .036 .029  MC
 .023 .097 .000 .000 .000 .000 .000 .000 .000 .000
 .000 .000 .000 .000 .000
 .053 .071 .071 .071 .070 .070 .069 .068 .066 .063  LDDV
 .059 .054 .046 .036 .029 .023 .018 .014 .011 .009
 .007 .006 .005 .004 .010
 .058 .077 .077 .076 .075 .072 .069 .066 .061 .056  LDDT
```

```
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 .008 .008 .007 .007 .036
 .048 .088 .080 .073 .066 .078 .069 .082 .063 .061  2BHDDV
 .045 .035 .027 .028 .035 .032 .032 .028 .025 .001
 .000 .000 .000 .000 .000
 .055 .102 .094 .087 .080 .078 .071 .068 .061 .055  LHDDV
 .051 .045 .037 .030 .027 .020 .015 .013 .010 .001
 .000 .000 .000 .000 .001
 .047 .089 .083 .078 .073 .067 .057 .056 .050 .049  MHDDV
 .045 .037 .033 .034 .031 .029 .026 .021 .021 .022
 .016 .010 .008 .005 .014
 .039 .073 .068 .064 .059 .056 .052 .049 .046 .043  HHDDV
 .040 .037 .035 .033 .030 .029 .027 .025 .023 .022
 .020 .019 .018 .017 .080
 .049 .092 .086 .081 .077 .068 .062 .061 .063 .057  BUSES
 .052 .046 .043 .040 .035 .026 .018 .012 .011 .008
 .003 .003 .002 .002 .004
1 2000 1 15.0                : region, year, speed cycle, speed
 1.6 0.90 1                  : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                           : number of precip. days
2002 Arterial CANYON Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                         : fleet average vehicle weight
1 2000 1 36.3                : region, year, speed cycle, speed
 1.6 0.90 1                  : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial CANYON Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 54.1                : region, year, speed cycle, speed
 1.6 0.90 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial CANYON Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 24.7                : region, year, speed cycle, speed
 1.6 0.90 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial CANYON Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 36.4                : region, year, speed cycle, speed
 1.6 0.90 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial CANYON Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 35.3                : region, year, speed cycle, speed
 1.6 0.90 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial CANYON Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
6000                : fleet average vehicle weight
1 2000 1 36.6                : region, year, speed cycle, speed
 1.6 0.90 1                : unpaved silt%, ind. silt g/m^2, WHEELFLG
91                : number of precip. days
2002 Arterial CANYON Low Avg *BASELINE*                :scene name
10.           -- Particle size cutoff
                  6000                : fleet average vehicle weight
```

Appendix B

Development of the
Northern Ada County
PM_{10} Maintenance Plan

Final Report for Part 4:

Dispersion Modeling for the
PM_{10} Maintenance SIP

DEVELOPMENT OF THE NORTHERN ADA COUNTY PM_{10} MAINTENANCE PLAN

Final Report for Part 4:

DISPERSION MODELING FOR THE PM_{10} MAINTENANCE SIP

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ENVIRON

1.0 INTRODUCTION

The Idaho Department of Environmental Quality is required to submit a PM_{10} Maintenance Plan for Northern Ada County to the U.S. Environmental Protection Agency by September 30, 2002. The maintenance plan must show that over the next ten years the region continues to meet the episodic (24-hour) and annual PM_{10} National Ambient Air Quality Standards set forth in the Clean Air Act Amendments of 1990. The forecast of PM_{10} air quality into the future is achieved through computer modeling.

This report provides the technical documentation that describes the development of a PM_{10} dispersion modeling database for Northern Ada County and its use to evaluate projected episodic PM_{10} air quality in several future years. The modeling approach follows from the Dispersion Modeling Protocol (ENVIRON, 2001), which was developed in the initial stages of this study. A modeling protocol is needed whenever dispersion modeling is carried out to support the development of a State Implementation or Maintenance Plan. The requirements for a modeling protocol are described in two U.S. Environmental Protection Agency (EPA) documents (EPA, 1991; EPA, 2001).

1.1 BACKGROUND

The city of Boise in northern Ada County lies in the Boise River Valley at an elevation of 2700 feet. This valley is situated within the larger Treasure Valley, which is oriented southeast to northwest along the Snake River, with mountains located to the southwest, east and northeast. The terrain is classified primarily as high desert country. Boise currently has an estimated population of 168,000, up from 135,000 (24.6%) in 1990, 102,000 in 1980 (64.7%), and 75,000 in 1970 (124%). The Boise/Northern Ada County PM_{10} Non-Attainment Area, which is co-terminus with the CO Non-Attainment area boundary, consists of nearly all the populated portion of Ada County. Ada County has likewise grown very rapidly over the past thirty years, rising from 112,000 in 1970 to 283,400 in 1999 (153%). The entire Metropolitan Statistical Area, which is known as the “Boise City MSA” and includes neighboring Canyon County, had a population of 408,000 in 1999. Since 1990, it has increased its metropolitan area ranking from 117 to 97th largest in the United States. It is the fourth fastest growing metropolitan area (on a percentage basis) in the country since 1990. These statistics are presented to provide a background on why attainment and especially the maintenance of air quality standards will be so challenging in Boise during the upcoming years.

Ada County has a history of high particulate levels, generally in the winter and fall seasons. In the winter, cold air masses enter the basin following the passage of cold fronts and can stagnate over the area for many days. High static stability, low winds, and the common occurrence of snow promotes valley fog, all of which help to build up PM_{10} levels in the valley from both primary and secondary sources. Primary PM includes road dust and elemental carbon and organics from wood smoke, while secondary PM includes sulfates, nitrates and ammonia from a variety of sources.

1.1.1 Chronology of PM_{10} Regulatory Status

- November 1970: The Boise Metropolitan Area (Ada and Canyon Counties) was designated by the National Air Pollution Control Administration (EPA's predecessor air agency) as an Air Quality Control Region and thus initiated the requirement to set standards and develop control plans.

- 1986: Northern Ada County was designated by EPA as a Moderate Non-Attainment Area for PM_{10} due to violations of the 24-hour PM_{10} standard. The annual standard has never been violated since monitoring began.

- November 1991: The Idaho Department of Environmental Quality (IDEQ) submitted to EPA a moderate area PM_{10} SIP as required under the 1990 Clean Air Act Amendments. The PM_{10} mobile source emission budget of this plan later became the de-facto transportation budget for conformity purposes. Key to the 1991 SIP submittal was a residential wood-burning control program.

- September 1994: The EPA acted on the 1991 SIP submittal, proposing to approve the emissions inventory and disapprove the control measures, including the attainment demonstration. The SIP did not include approved wood smoke ordinances for several areas that constituted a portion of the attainment demonstration.

- December 1994: The IDEQ submitted a revised SIP, which included adopted, enforceable wood smoke ordinances for all areas covered in the attainment demonstration.

- 1995: Northern Ada County adopted wintertime road sweeping practices as a contingency measure to control on-road fugitive dust emissions. The IDEQ also obtained an agreement with the Idaho DOT to reduce particulate by prioritized road sanding of those streets having highest potential road dust PM_{10}.

- May 1996: The EPA took final action to approve the entire PM_{10} SIP for Northern Ada County. This was done as a Direct Final Rule.

- July 1997: The EPA revised the NAAQS for PM, adding a new standard for $PM_{2.5}$ and allowing states to "transition" from the old standards to the new as long as they met certain specific requirements.

- July 1998: The IDEQ requested EPA to revoke the non-attainment status of the pre-1997 NAAQS, in order for the Northern Ada County area to opt into the transitional area designation thereby lifting the transportation conformity requirement.

- October 1998: The EPA proposed to approve the IDEQ request to revoke the non-attainment status.

- March 1999: The EPA took final action to revoke Northern Ada County's non-attainment designation for the pre-1997 NAAQS as it met the requirements of EPA's guidance to determine attainment (attainment during 1994-96, fully approved SIP, and legal authority to implement the revised PM_{10} and $PM_{2.5}$ standards if necessary). Numerous comments were received opposing this action, particularly from environmental groups over the removal of conformity requirements due to the revocation. EPA's position was that "conformity doesn't solely determine attainment."

- May 1999: A U.S. Court of Appeals ruling vacated the new revised PM standards and therefore left Ada County as the only area in the nation without any applicable PM standard in place. Other areas, such as Medford, Oregon, were in the process of getting final EPA action to revoke the old standard when this decision occurred.

- 1999 to present: Litigation by the Idaho Clean Air Force and the Environmental Defense Fund against the EPA requested re-instatement of the pre-1997 PM_{10} standard and thus reestablished associated transportation conformity requirements.

- November 2000: As settlement neared, the IDEQ proposed a rule to address growth in transportation related PM_{10} emissions to "fill the conformity gap", while they develop an approvable Maintenance SIP by September 30, 2002. Public hearings on this rule occurred on December 5, and the Board adopted rule in early 2001.

1.1.2 Characterization of PM_{10} Air Quality in Northern Ada County

The following conceptual model is based on information provided by IDEQ. The worst PM events occur in Ada County in the wintertime, as cold air masses enter the basin following the passage of cold fronts. As the associated high pressure system settles into the northwest and Great Basin areas, high static stability and stagnation builds to trap the cold air in the valley for many days. During this time, very little ventilation occurs by vertical mixing or by horizontal transport out of the valley. A very light but distinct topographically-driven valley circulation sets up, with drainage flow at night moving down from the surrounding mountains and along the river basin to the northwest, reversing to a thermally-driven flow during the day moving up the basin (to the southeast).

Without a means of ventilation, PM levels increase day-to-day during these episodes from both primary and secondary sources, and tend to peak by the third day. Primary sources include wood smoke and road sanding when snowfall was recently present. A large geogenic component has been identified in "high" ($\sim 100 \mu g/m^3$) PM_{10} episode filter data from the 1990's, with the highest fractions occurring during relatively high winds, and much lower fractions occurring during episodes with significant snow cover (IDEQ, 1996; DRI, 1998). Secondary PM has been measured to be at times more than 50 percent of the total PM_{10}, and includes sulfates and nitrates (DRI, 2000). Both secondary species are preferentially formed in the cool foggy environments that set up during these episodes. In extreme events, snow cover is present for an extended period which increases radiative cooling and maintains temperatures near or below the freezing point, heightens the strength and depth of the deep stable layer, and promotes the formation of valley fog. The breakup of the PM episode is usually accompanied by precipitation.

Monitoring of particulate matter began in Ada County in 1986 at three sites. At present there are five PM_{10} monitoring sites in Ada and Canyon Counties (Table 1-1). The last actual exceedance of the 24-hour PM_{10} NAAQS occurred during a particularly cold episode in January of 1991, and PM_{10} levels measured during that episode remain the highest on record. Since then, other high but non-exceedance PM_{10} episodes (> 100 µg/m^3) have occurred in December 1991, February 1993, December 1994, October 1995, and August 1996. The lack of exceedance episodes in the past ten years has been attributed to the absence of intense stagnation events such as occurred in January 1991, and to controls on primary PM emissions in the valley. The annual PM_{10} standard has never been exceeded in the Treasure Valley.

Table 1-1. Current PM_{10} sites operating in the Treasure Valley.

PM_{10} Site	**Site ID**	**Max 24-hour PM_{10} (µg/m^3)**
Liberty Fire Station, Boise	16-001-0003	140 (1/7/91)
Fire Station #5, Boise	16-001-0009	173 (1/7/86)
Mountain View School, Boise	16-001-0011	164 (1/7/91)
1516 First St., Meridian	16-001-0013	100 (8/13/96)
923 First St., Nampa	16-001-0027	131 (8/13/96)

In winter 1999/2000, the IDEQ and DRI undertook a field study to measure and model, via equilibrium considerations, secondary aerosol formation in the Treasure Valley (DRI, 2000). During that season, peak PM_{10} levels reached only moderate levels (a second-high of 68 µg/m^3 on December 24, 1999), while peak $PM_{2.5}$ levels reached 41 µg/m^3. Although absolute concentrations were lower than previous episodes occurring in the 1990's, the relative distribution of PM chemical species was similar to that observed in past exceedance episodes (DRI, 2000). Both measurements and secondary aerosol chemical equilibrium modeling suggested that the formation of nitrate aerosol is limited by the availability of nitric acid and not by ammonia. This latest research indicates that secondary aerosols have, and are currently, a major fraction of PM_{10} in the Treasure Valley, and thus cannot be ignored in modeling exercises.

Additional information on episodic PM_{10} measurements is presented in Section 2, "Episode Selection."

1.2 PURPOSE AND OBJECTIVES OF THE CURRENT STUDY

The primary objective of this project is to develop a PM_{10} Maintenance Plan for Northern Ada County, to be completed and submitted to EPA by September 30, 2002. The development of this plan is based upon new modeling and data analyses, including: (1) the development of a new PM_{10} emissions inventory for the 1999 base year, and for the future years of 2010, 2015, and 2020; (2) new receptor modeling using data from the January 1991 exceedance episode and the winter 1999-2000 field study; (3) new episodic dispersion modeling with a photochemical grid model that includes improved wintertime meteorological characterization of the Treasure Valley and non-linear secondary aerosol formation; and (4) new speciated linear rollback calculations to evaluate annual PM_{10} levels in the three future years.

This report describes results from the activities of item (3) above. Specifically, it provides a technical summary of the dispersion modeling system, configuration, and approach for evaluating model performance over a historical episode, and for estimating 24-hour PM_{10} concentrations in the three future years of 2010, 2015, and 2020. The methods described here follow the Dispersion Modeling Protocol (ENVIRON, 2001), which is based upon EPA guidance for PM modeling (EPA, 1987; EPA, 2001). The EPA, Region X, has concurred with and approved the methodologies set forth in the Modeling Protocol. Supplementary companion reports provide information on emissions inventory development, meteorological modeling, receptor modeling, and annual rollback modeling.

1.2.1 Overview of Approach

The dispersion model selected for this study was CAMx, an Eulerian (gridded) photochemical model with a reduced-form aerosol chemistry algorithm. The modeling grid domain was configured to cover the focus area of Ada and Canyon Counties, and surrounding environs, with 1 km grid cell size. The vertical depth of the domain extended from the surface to about 1500 m. CAMx was supplied with hourly three-dimensional gridded meteorological fields (winds, temperature, pressure, moisture, clouds) generated from the MM5 meteorological model (Dudhia, 1993). The development and evaluation of meteorological fields with MM5 are fully described in a supplementary Meteorological Modeling report. CAMx was first applied to a December 1999 PM episode using episode-specific emissions and meteorology to establish and demonstrate acceptable model performance in replicating 24-hour PM_{10} levels. Then the model was used to estimate 24-hour PM_{10} levels in three future years by simulating the worst case meteorological conditions of the January 1991 exceedance episode in combination with future year episodic emission inventories.

The annual PM_{10} standard has never been exceeded in Northern Ada County and it would appear that annual-average concentrations will continue to remain below the standard in the immediate future. However, both 24-hour and annual standards must be addressed in modeling for Maintenance Plans, especially given the long-range projections to 2020. Therefore, the annual modeling component was addressed using the speciated linear rollback technique. This approach utilizes the results of receptor modeling conducted by DRI (2000), in combination with future year projected county-level emissions inventories. Receptor modeling establishes speciated mass budgets of total measured PM_{10} and then determines "transfer coefficients" that quantify the source attribution of each aerosol chemical species to specific emission categories. Speciated linear rollback applies the future year emission projections to the transfer coefficients, thus yielding a commensurate change to the aerosol mass budgets and ultimately a forecast of the total PM_{10} in those future years. This approach and results of this activity are described in detail in the supplemental Annual Modeling report.

2.0 EPISODE SELECTION

Meteorological conditions leading to measured PM_{10} exceedances in Ada County were examined to determine an appropriate worst case meteorological episode for attainment demonstration purposes. The episodes examined led to the exceedances shown in Table 2-1 below. Multi-day episodes were defined to consider the build-up and eventual break-up of stagnation conditions leading to elevated particulate levels. The episodes are:

December 11, 1985 to January 1, 1986;
January 7-15, 1986;
January 20-29, 1988; and
January 4-7, 1991.

These episodes represent the most extreme cases of the meteorological conditions conducive to the formation of elevated PM_{10} concentrations since monitoring began in December 1985.

Table 2-1. Daily exceedances of PM_{10} in Ada County, Idaho, with associated meteorological data.

Year	Month	Day	Site	PM_{10} ($\mu g\ m^{-3}$)	Avg Temp (°C)	Avg WS (mph)	Avg WD (deg)	Precip (in/day)
1986	Jan	14	FS5	314	-10	5.5	175	0.00
1988	Jan	28	FS5	165	-2	5.2	214	0.00
1991	Jan	7	FS5	173	-8	5.9	244	0.09
1991	Jan	7	MVS	164	-8	5.9	244	0.09

Detailed descriptions of the episodes and PM_{10} exceedances are provided below. Surface data were collected at the NWS station at the Boise airport (43°34'N, 116°13'W, elevation 2,840 feet). Upper-air data were collected twice daily (0500 and 1700 LST), also at the Boise airport, as a part of the global rawinsonde network. PM_{10} concentration data were collected and quality assured by the IDEQ.

2.1 EPISODE 1: 11 December 1985 to 1 January 1986

A significant stagnation episode occurred in Treasure Valley during the last three weeks of December 1985. This situation was governed by an intense surface high-pressure system in the area. Nineteen days during this period met the conditions for deep, stable layers. Figures 2-1 (a-c) show time series of hourly surface temperature, wind speed, and relative humidity for all of December 1985.

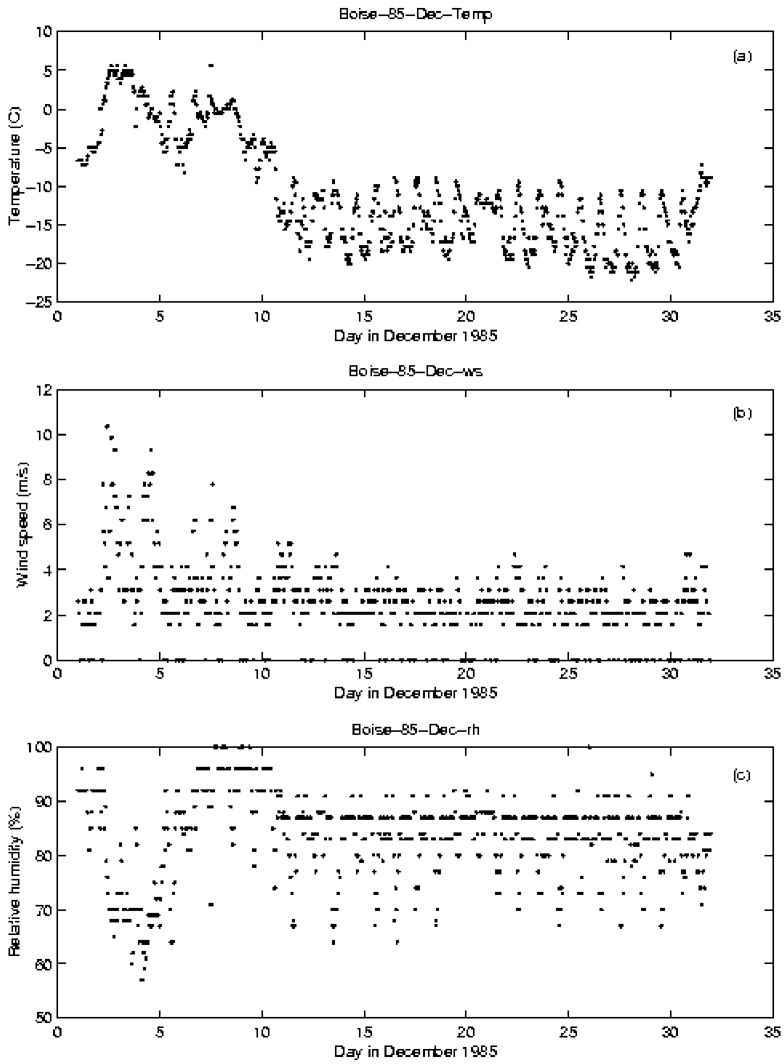


Figure 2-1. Time series of surface temperature (a), wind speed (b), and relative humidity (c) at Boise, Idaho, for December 1985.

From the eleventh until the end of December, the temperature was significantly lower than average, with a maximum of only about -10°C and the minimum lower than -20°C on 28 December. Wind speeds were generally below 5 ms^{-1}, and the nighttime relative humidity was greater than 80%. The wind direction generally had a westerly component during the afternoon and was easterly otherwise. About 7 to 8 inches of snow was covering the ground. All of these conditions facilitated the development of a strong, surface-based inversion. Consequently, vertical mixing was significantly suppressed, and the pollutants were trapped near the surface. Visibility was significantly impaired by the presence of fog and pollutant plumes, especially between 14 and 31 December.

Figure 2-2 shows a wind rose for the December 1985 hourly surface observations for Boise. Due to channeling within the valley, the winds were southeasterly or northwesterly nearly 50% of the time. The highest speeds were in the range 12.7-18.4 mph, butoccurred only 2% of the time. More than 20% of the observations showed calm winds.

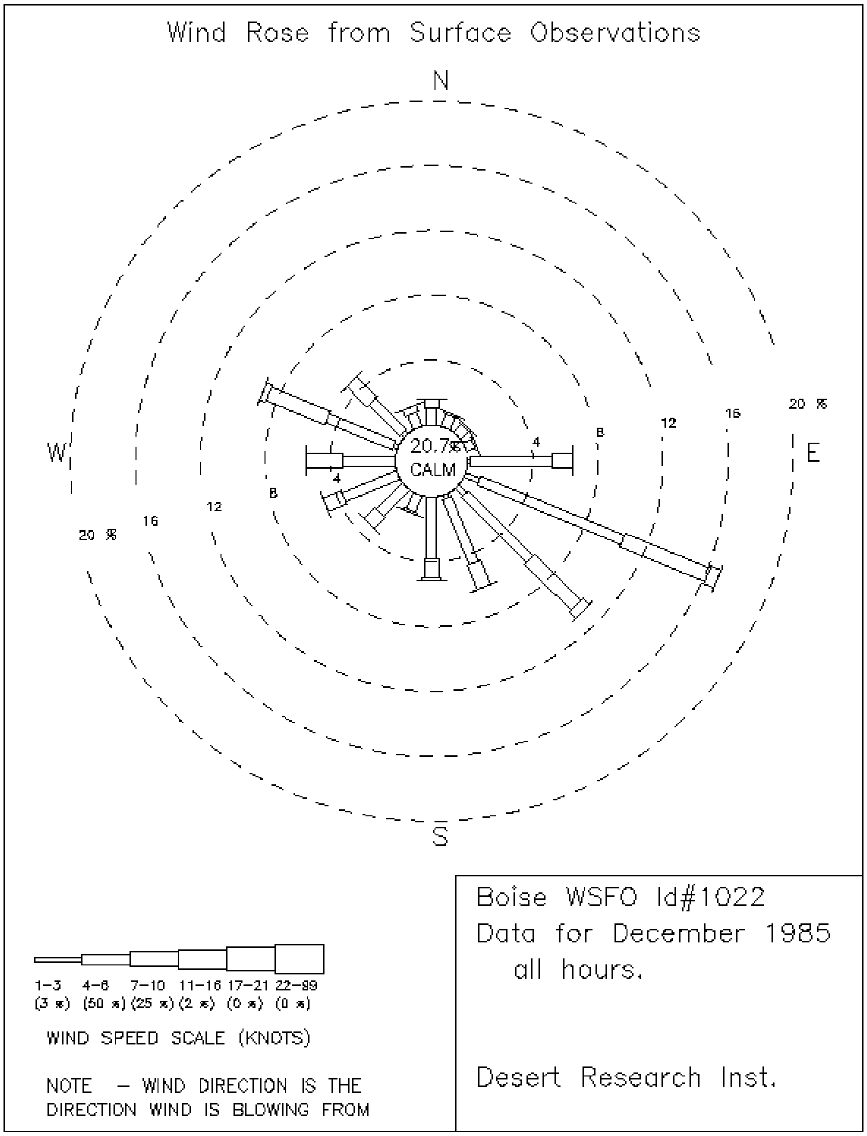


Figure 2-2. Wind rose from surface observations at Boise, December 1985.

The 24-hour PM_{10} concentrations exceeded the NAAQS on all days of the stagnation period. However, during this episode, PM_{10} monitors were only recently placed in operation and calibration was not properly performed. Consequently, the measurement results are "unofficial".

Stagnation conditions and associated stable stratification can also be characterized by the magnitude of the potential temperature gradient as measured by theradiosonde at Boise at 0500 and 1700 LST. Figure 2-3 shows the value of the potential temperature gradient in the lowest kilometer of the atmosphere.

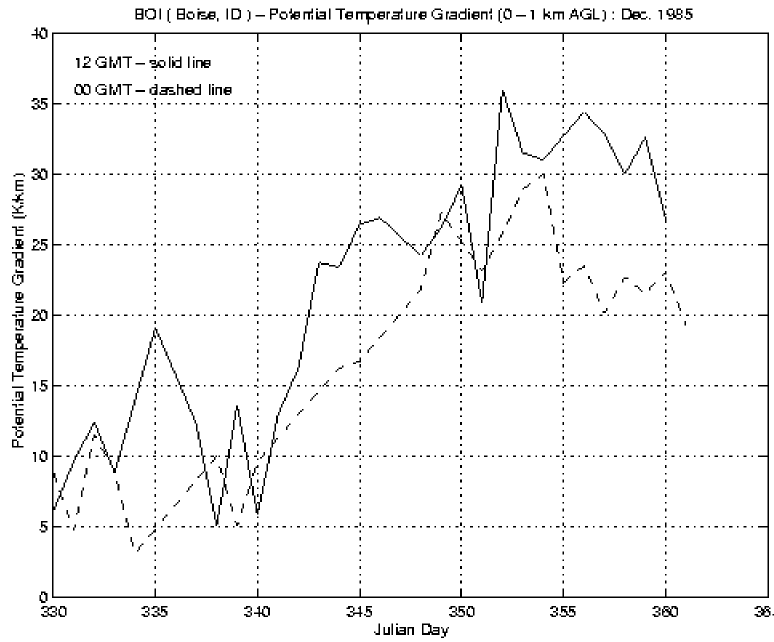


Figure 2-3. Vertical gradient of the potential temperature from the radiosonde data from Boise, Idaho, for December 1985.

The figure clearly shows that the potential temperature gradient was significantly larger (more stable) during the last three weeks of December than in the beginning of December. The peak value of 36 K km^{-1} was measured during the latter period. The stagnation episode ended on 1 January 1986 due to a frontal passage that brought a rapid increase in both temperature and wind speed as well as a decrease in relative humidity (Figures 2-1a-c). This change in weather conditions significantly improved air quality in the area.

2.2 EPISODE 2: 7 - 15 January 1986

Conditions favorable to poor air quality occurred between 7 and 15 January 1986. Although the days from 7 through 9 January met conditions for deep, stable layers, the surface temperature was variable and relatively high as compared to the period between 10 and 15 January (Figure 2-4a). Wind speeds were also higher between 7 and 9 January as compared to the period between 10 and 15 January (Figure 2-4b). Relative humidity was more variable and generally lower during the first period as compared to the second period (Figure 2-4c).

Figure 2-5 shows January 1986 hourly surface wind observations for Boise. Again, the winds are generally southeasterly or northwesterly, with southeasterly predominating. Wind speeds are mainly in the 4.6-6.9 mph range, with the highest speeds in the 12.7-18.4 mph range during 3% of observations.

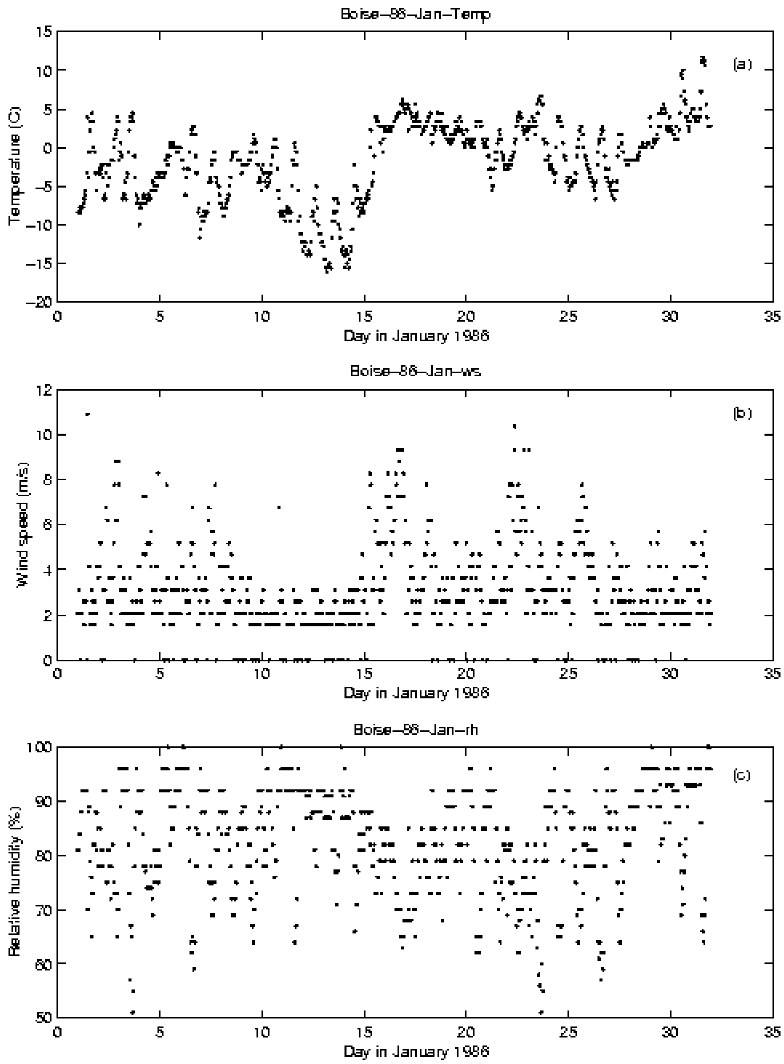


Figure 2-4. Time series of surface temperature (a), wind speed (b), and relative humidity (c) at Boise, Idaho, for January 1986.

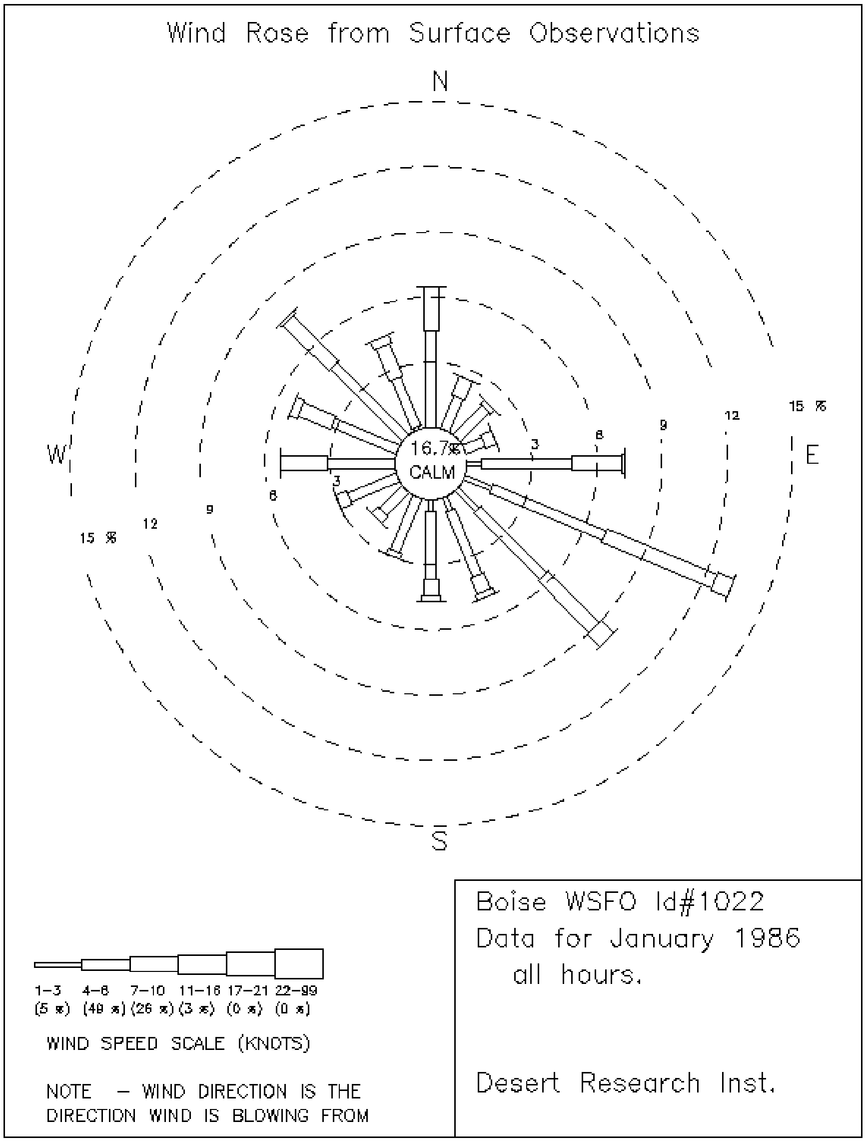


Figure 2-5. Wind rose from surface observations at Boise, January 1986.

On 8 January, the 24-hour PM_{10} concentration measured at FS5 was 91, and the reading at MVS was 89 µg m^{-3} (Figure 2-6). A large 24-hour PM_{10} NAAQS exceedance of 314 µg m^{-3} was recorded at FS5 on 14 January (Figure 2-6). Unfortunately, the sampling days were quite sparse, and only one station measured PM_{10} on a single day between 9 and 19 January. However, it is important to note that during all five sampling days the PM_{10} concentrations were larger than 79 µg m^{-3}, with the absolute maximum for Treasure Valley recorded on 14 January. Upper air measurements clearly show strong stability and an associated very large potential temperature gradient (Figure 2-7), with a maximum of 33 K km^{1} around the exceedance day (14 January).

At the end of this episode, a low-pressure weather system approached the area, disrupted stagnation conditions, and significantly improved the air quality in Treasure Valley.

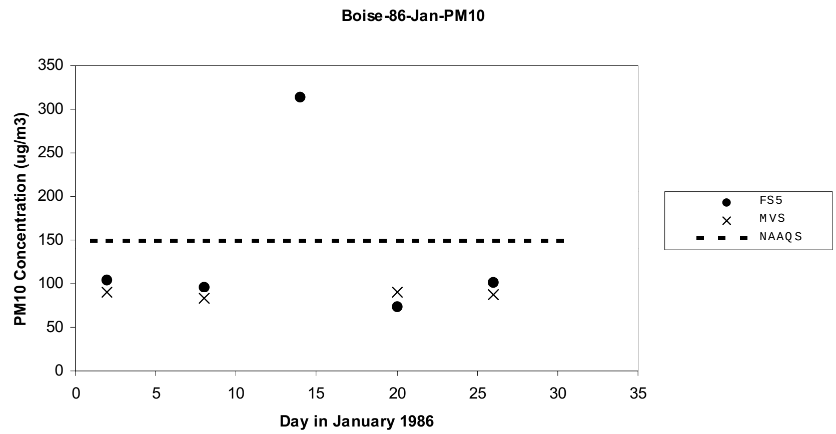


Figure 2-6. PM10 concentrations for Boise, Idaho, in January 1986.

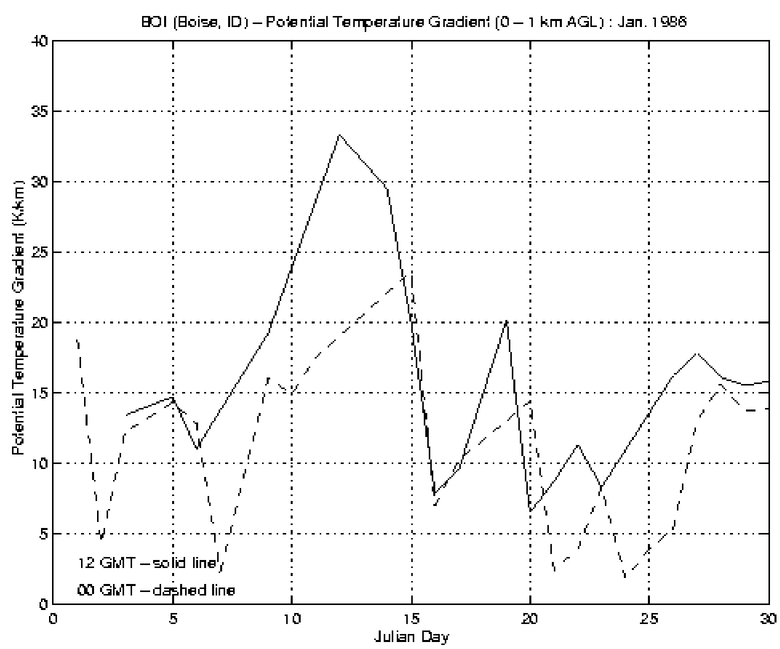


Figure 2-7. Vertical gradient of potential temperature from the radiosonde data at Boise Idaho, for January 1986.

2.3 EPISODE 3: 20 - 29 January 1988

A high pressure weather system dominated the area from 20 through 28 January 1988. Deep stable layers were formed, and fog and plumes were frequently observed during this period. Time series of surface observations are shown in Figures 2-8.

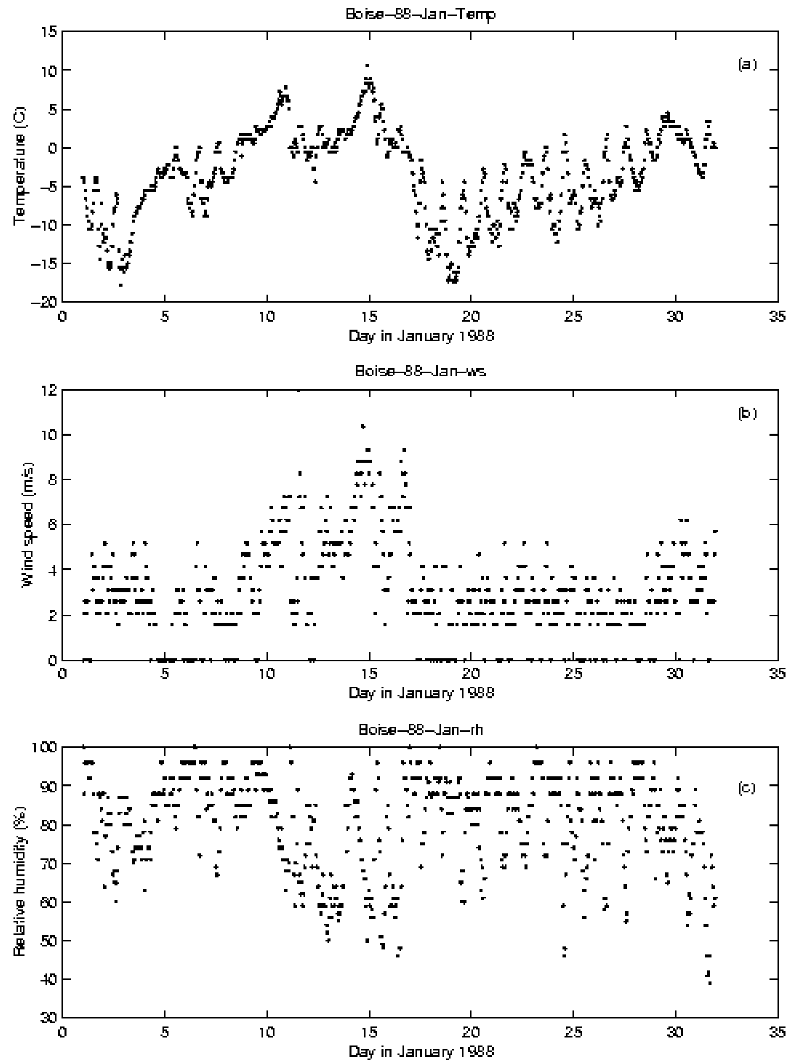


Figure 2-8. Time series of surface temperature (a), wind speed (b), and relative humidity (c) at Boise, Idaho, for January 1988.

Figure 2-9 shows the wind rose for January 1988. Winds for this month were predominantly southeasterly, with very few readings from other directions. Highest speeds were once again in the 12.7-18.4 mph range (5% of readings), but the winds were in the 4.6-11.5 mph range 67% of the time. Almost 25% of observations were calm.

From 15 to 20 January, the surface temperature dropped by about 28°C (from +10°C to -18°C) (Figure 2-8a), wind speeds were significantly reduced (Figure 2-8b), and relative humidity was generally higher than 70% (Figure 2-8c). This buildup of stagnation conditions resulted in an exceedance of the 24-hour NAAQS of165 µg m^{-3}. A large PM_{10} concentration of 150 µg m^{-3} was measured at MVS on 28 January (Figure 2-10).

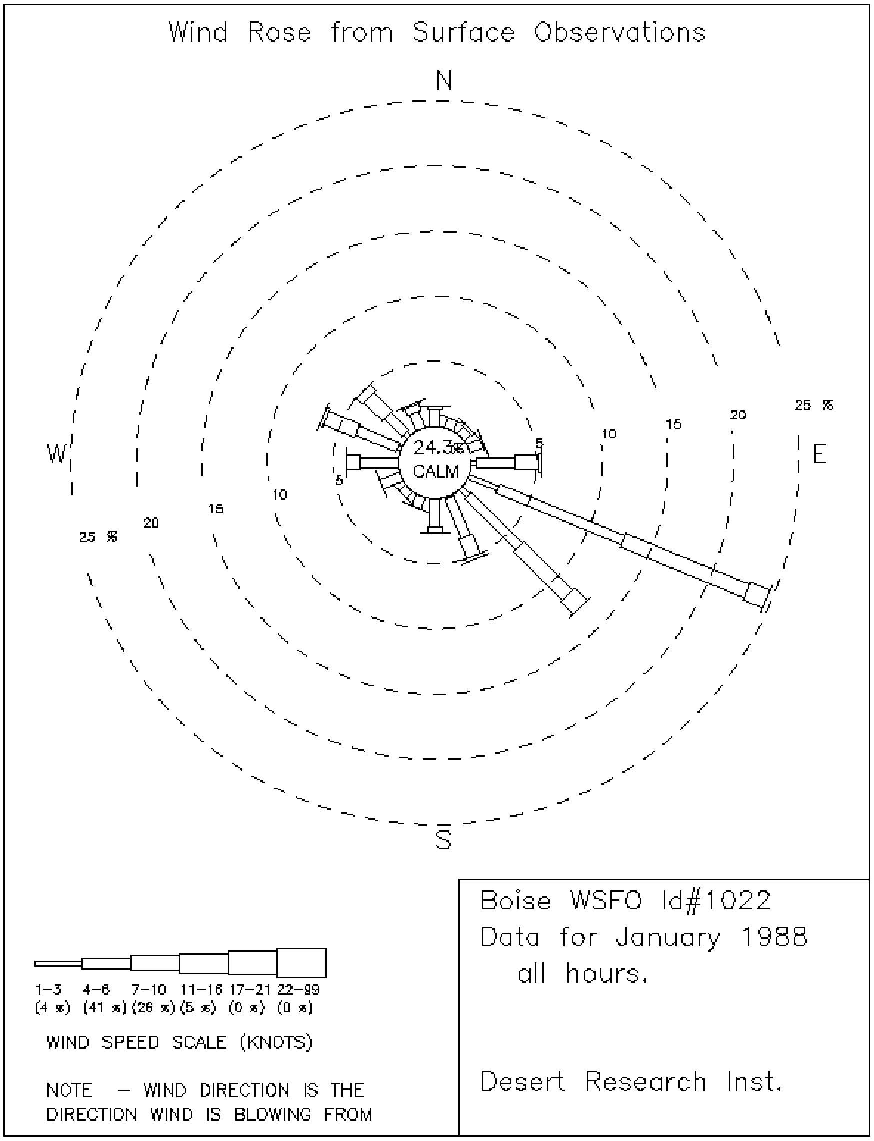


Figure 2-9. Wind Rose from Surface Observations at Boise, January 1988.

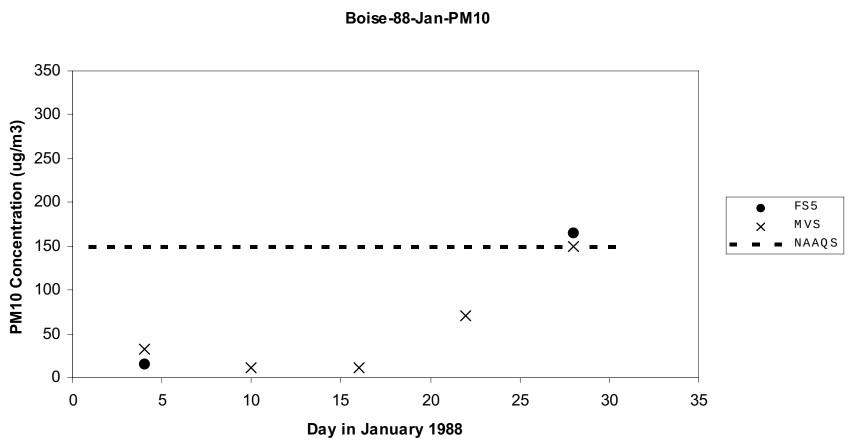


Figure 2-10. PM_{10} concentrations for Boise, Idaho, in January 1988.

During the exceedance episode, the mixing depth was reaching only about 250 m in the afternoon. The wind was easterly during the morning hours and westerly in the afternoon hours. Figures 2-8b and c show that the exceedances were associated with a minimum of surface wind and high relative humidity. Vertical potential temperature gradient was smaller (reaching about 20 K km^{-1}) as compared to the previous two examples, but the rapid increase and maintenance of the large values are clearly shown in the second part of the month (Figure 2-11).

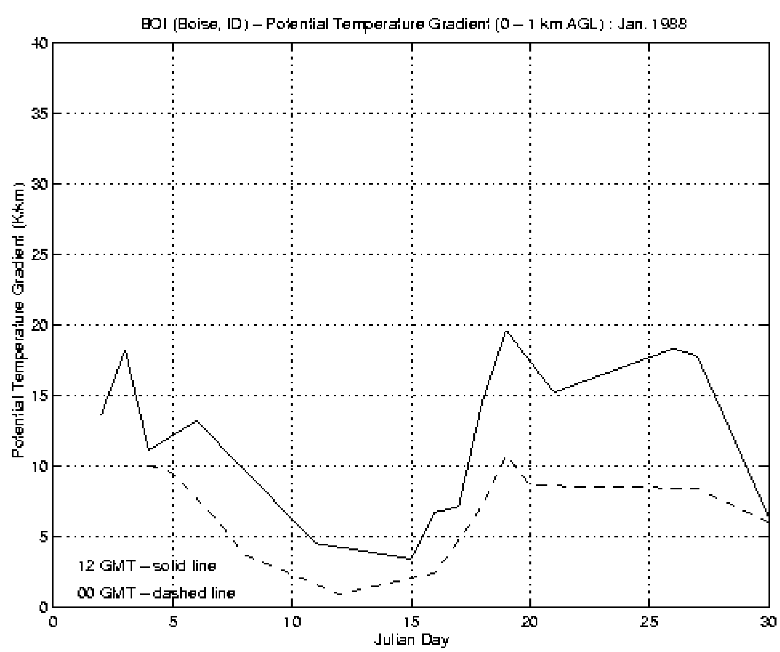


Figure 2-11. Vertical gradient of potential temperature from the radiosonde data from Boise, Idaho, for January 1988.

2.4 EPISODE 4: 4 - 7 January 1991

A stagnation episode occurred in early January 1991. The first six days in January were associated with very low temperatures between -6 °C and -24 °C (Figure 1-6a). Winds were very low and generally below 3 ms^{1} (Figure 1-6b). Relative humidity was generally above 80% (Figure 1-6c).

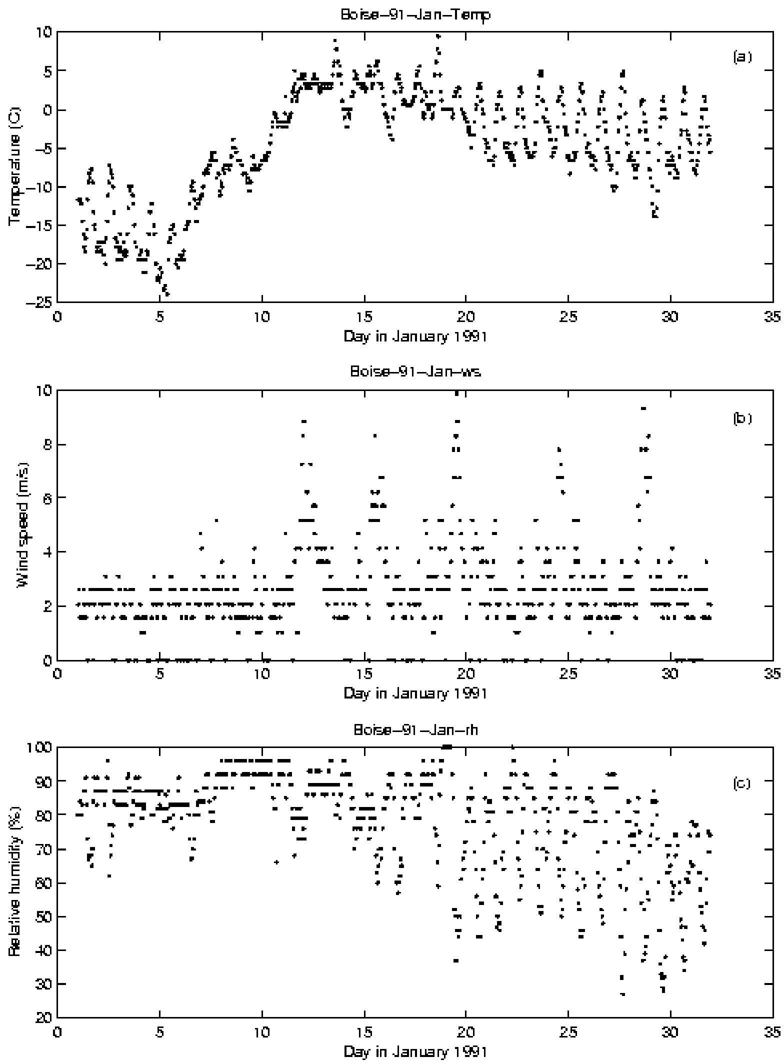


Figure 2-12. Time series of surface temperature (a), wind speed (b), and relative humidity (c) at Boise, Idaho, for January 1991.

Figure 2-13 shows the wind rose for January 1991. Once again, southeasterly and northwesterly winds predominate (59%), with speeds generally in the 4.6-6.9 mph range for 59% of the time. Calm winds were present for 16.4% of the observations.

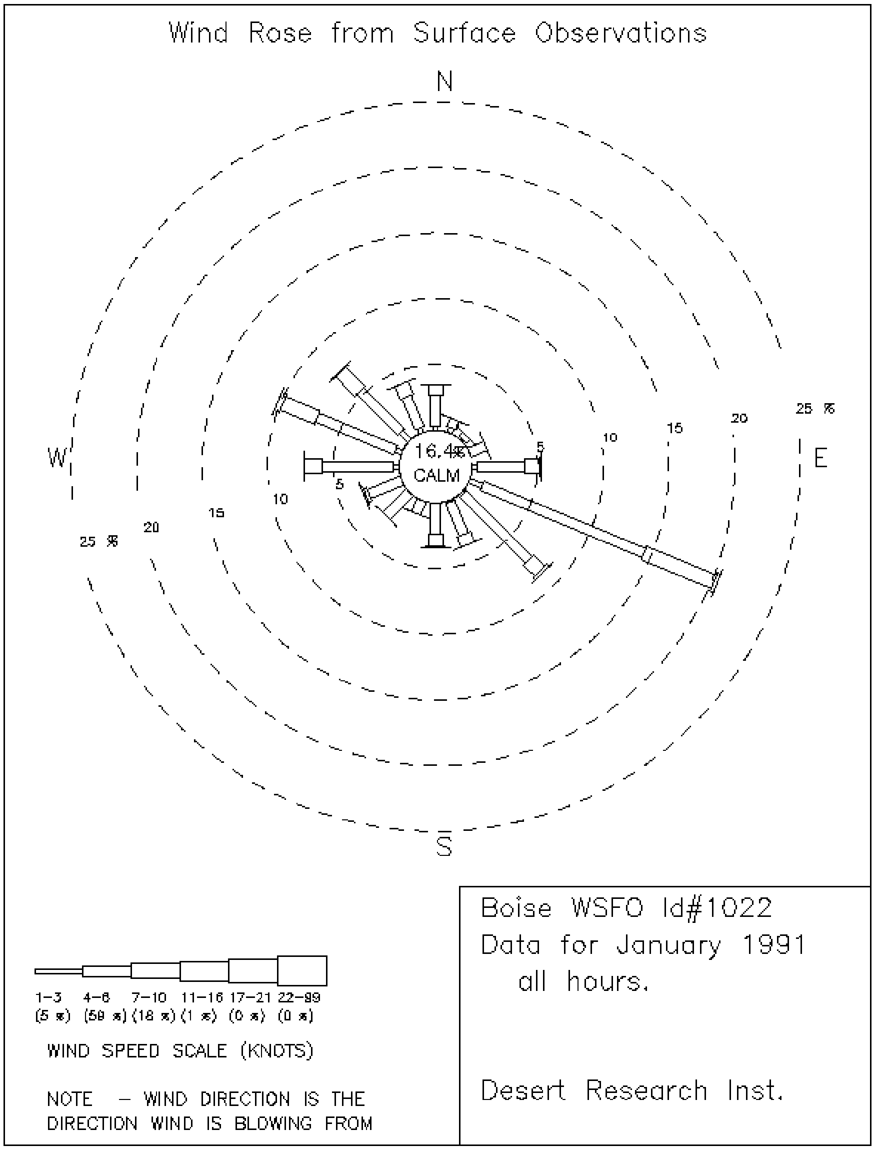


Figure 2-13. Wind rose from surface observations at Boise, January 1991.

These very cold days were associated with deep, stable layers and degradation of air quality. PM_{10} measurements showed that the NAAQS was exceeded on 4, 6, and 7 January (Figure 2-14). MVS recorded high values, including exceedances on 4 (152) and 7 (164) January; FS5 recorded exceedances on 6 (151) and 7 (173 $\mu g\ m^{-3}$) January. The air quality improved on 9 January, and PM_{10} concentrations measured at both stations were below 59 $\mu g\ m^{-3}$ (Figure 2-14). Figure 2-15 shows that the largest potential temperature gradient was measured in the beginning of the month. The largest values (about 28-30 K km^{-1}) were observed on 4 and 5 January. That period corresponds to the occurrence of exceedance.

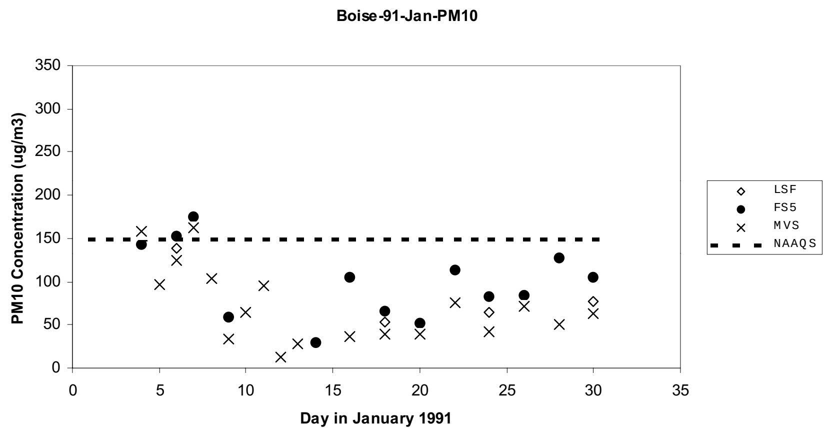


Figure 2-14. PM_{10} concentrations for Boise, Idaho, in January 1991.

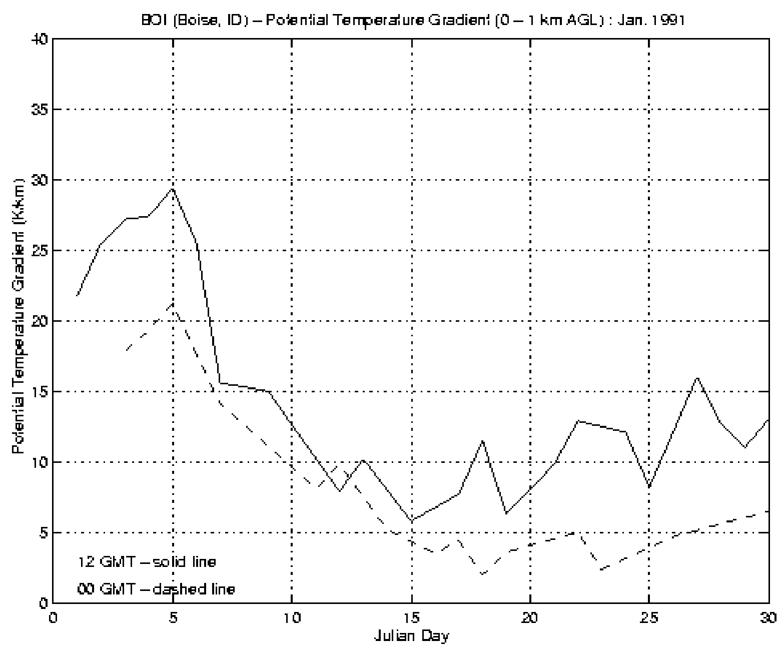


Figure 2-15. Vertical gradient of the potential temperature from the radiosonde data from Boise, Idaho, for January 1991.

2.5 THE TREASURE VALLEY SECONDARY AEROSOL STUDY

In winter 1999/2000, the IDEQ and DRI undertook a field study to measure secondary aerosol formation in the Treasure Valley (DRI, 2000). During that season, peak PM_{10} levels reached only moderate levels (70 μg/m^3) over the particularly stable and stagnant period of December 20-24, 1999. Although absolute concentrations were lower in December 1999 than previous "high" (~100 μg/m^3) episodes occurring in the 1990's, according to DRI (2000) the relative contribution of particulate chemical species to total PM_{10} mass was similar to that observed in past exceedance episodes in 1988 and 1991. However, speciated data from DRI (1998) shows that a higher fraction of primary geogenic dust has been measured in all "high" PM_{10} episode filter samples of the 1990's, and this was similarly found in the December 1999 period. The data suggest that a certain paradigm shift has recently occurred from the highly secondary-laden PM_{10} exceedance episodes of the late 1980's and early 90's.

The 1999/2000 DRI study provided a much broader database for PM from seven monitoring sites. The standard IDEQ 24-hour PM_{10} measurements were available from four sites on December 20 and 26 (Boise Fire Station #5, Mountain View School, Meridian, andNampa); speciated 24-hour PM_{10} and 5-hour $PM_{2.5}$ filter samples were taken at two sites (Boise Fire Station #5 and the Cloverdale "background" site) each day between December 22 and December 25; and total 24-hour $PM_{2.5}$ was measured at three sites on December 20, 23, and 26 (White Pine School, Syringa School, and Mountain View School). In addition, hourly meteorological data were available from five sites in the region, including the NWS Boise airport, the IDEQ meteorological tower, the Caldwell airport, and the FS5 and Cloverdale $PM_{2.5}$ sites.

2.6 SELECTED EPISODES AND MODELING METHODOLOGY

Severe stagnation events leading to exceedances of the PM_{10} standard rarely occur in Northern Ada County. The last such event occurred in January 1991. Based upon the analysis of the historical meteorological conditions for the four episodes summarized above, IDEQ selected the January 1991 episode as the worst-case episode to be used for the attainment demonstration modeling. Although the 1985 episode produced a longer lasting and slightly stronger stagnation event, the event in January 1991 resulted when record-cold temperatures were measured in Northern Ada County. Furthermore, the January 1991 event was better documented by available monitoring data. The January 1991 event represents a severe stagnation event in which high PM_{10} levels occurred with significant amounts of secondary aerosol, and as such is the appropriate episode to represent worst-case meteorology for the Northern Ada County PM_{10} Maintenance Plan demonstration.

Complex meteorological and photochemical grid models require a substantive quantity of observational data to define various inputs, and to fully evaluate their predictive performance. Measurements of 24-hour PM_{10} measurements were available from two sites on all six days of the January 4-9, 1991 episode, as were speciated mass budgets at the two sites on January 4 and 7 (DRI, 1998). These were considered marginally sufficient to gauge dispersion model performance. However, this episode suffered from a lack of other data needed by the emissions and dispersion modeling efforts. Quality assured and audited meteorological data were only available from one site (the NWS site at Boise airport) during this period; the 1991 emissions inventory used in past modeling exercises focused on wood smoke, utilized crude estimates for other source sectors, and did not include secondary PM precursor emission rates (NOx, SOx, NH_3); and the 1995 revised emissions inventory did not entirely cover the larger modeling domain defined for this study. Furthermore, for this project the IDEQ placed a major emphasis on the "bottom-up" development of a more recent and detailed emission inventory from which to project future year budgets; resources and schedule were insufficient to hindcast the 1999 emissions inventory to 1991 with a level of certainty and technical quality needed for this study.

Given the data constraints of the 1991 episode, the improved PM and meteorological measurement database available from the 1999/2000 DRI Treasure Valley Secondary Aerosol Study, and the need for an updated emissions inventory with significantly more detail, it was decided that the base year dispersion model performance evaluation would be conducted for the December 20-24, 1999 episode. The CAMx model was provided with episode-specific hourly emission rates from the new 1999 inventory and with hourly three-dimensional meteorological fields from the MM5 model. Numerous simulations were undertaken to identify needed improvements to the inputs and to check model sensitivity. When the model performed adequately in characterizing PM conditions over the base year episode, the future year maintenance modeling was performed for 2010, 2015, and 2020 using projected emission inventories and MM5 meteorological fields developed for January 4-9, 1991. For completeness, the future year evaluation was also carried out using the December 20-24, 1999 meteorology as well. A diagram illustrating this approach is shown in Figure 2-16. The EPA concurred with, and approved this approach when the Modeling Protocol was developed.

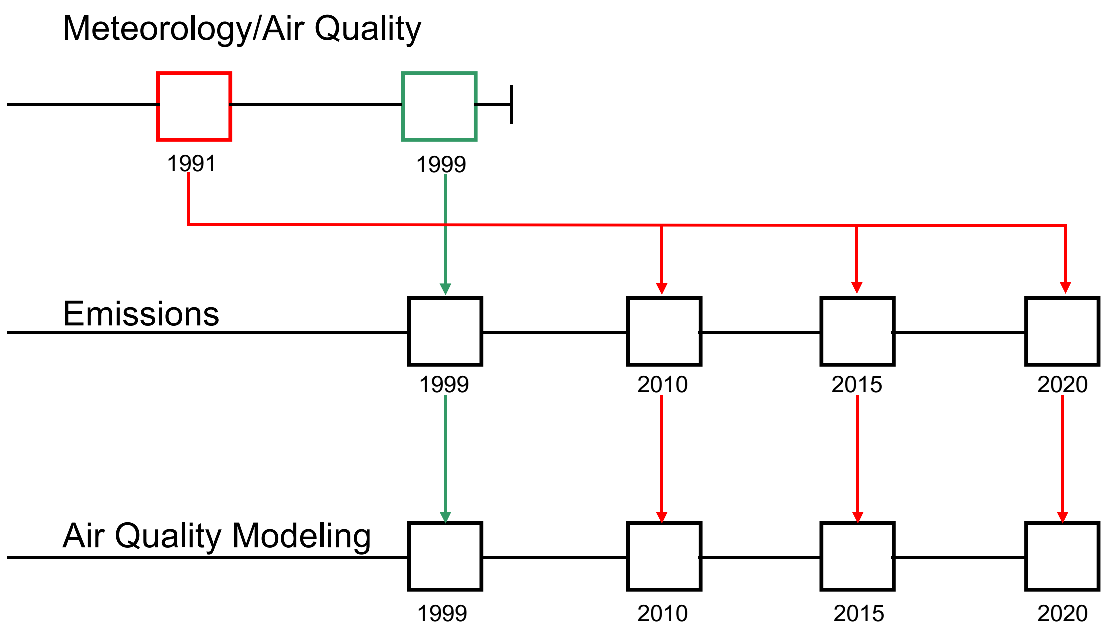


Figure 2-16. Time line showing an overview of how meteorological episodes were used in conjunction with emission estimates to yield air quality modeling results for the base and future years. The green path represents modeling of the base year for the model performance evaluation, i.e., the determination of how well the model replicated conditions in December 1999. The red path represents modeling of the future years, which combines meteorology from the January 1991 episode with future year emission estimates to yield predicted PM_0 air quality in the future years.

3.0 EPISODIC MODEL SELECTION

Several studies have been undertaken in the past to model future year PM_{10} conditions in the Northern Ada County (Boise) area of southwestern Idaho. These have included a variety of methodologies, including receptor modeling and speciated rollback (DRI 1998, 2000), Gaussian plume modeling with ISCST3, and grid modeling using WYNDvalley (Koracin et al., 1998, 2000). Results from all of these approaches have indicated that during worst-case episodic meteorological conditions (e.g., January 1991), estimated future year PM_{10} emission inventories lead to exceedances of the PM_{10} NAAQS after 2010. All of these approaches were acceptable according to past EPA PM_{10} SIP modeling guidance (EPA, 1987), and ISC and WYNDvalley have been listed as EPA preferred and alternative guideline air quality models, respectively (EPA, 1995).

These past modeling approaches focused on primary (directly emitted) PM_{10} constituents, including wood smoke and fugitive dust, and did not address secondary aerosols that are chemically formed in the atmosphere from precursors. However, as controls on the sources of primary constituents have lowered PM_{10} levels in Northern Ada County, secondary PM has become a larger relative fraction of the PM_{10} loading. It is conceptually possible that rapid growth in population, industry, and motor vehicle activity may drive secondary PM to be a major contributor to exceedances in the future. Furthermore, new EPA guidance on modeling for the fine PM standard (EPA, 2001) describes the need for modeling systems to adequately treat the processes associated with secondary PM formation. Therefore, it was imperative that the current PM_{10} modeling effort for Ada County employ a more rigorous modeling approach than previous studies.

3.1 EULERIAN PM AIR QUALITY MODELS

A grid-based "Eulerian" dispersion model was the best candidate for the current study given the fact that the inherent assumptions in plume models break down over the large extent of the modeling domain and the complex topography that surrounds the basin. For example, stagnant conditions lead to light and variable wind patterns across the Treasure Valley that cannot be properly treated using a plume model. Most plume models ignore chemical secondary aerosol formation, while some puff models (e.g. CALPUFF) treat secondary aerosol formation in a simple linear fashion. A more up-to-date Eulerian air quality model was needed to adequately treat these processes. The Eulerian WYNDvalley model is based on 1980s modeling technology and is considered to be too simplistic by today's modeling standards, both in terms of transport/diffusion and its capability to handle only primary inert PM.

The EPA's current Air Quality Modeling Guideline (40CFR51 Appendix W) does not include recommendations for any specific model for applications where secondary aerosol is the dominant factor of an area's PM_{10} problem. This is because the scientific basis for secondary aerosol formation is not well understood and no individual model has adequately demonstrated consistently good performance. The EPA recommends that States determine the specific attributes necessary in a qualifying model to address the secondary aerosol problem, and choose among models possessing these attributes. Then the regional EPA offices, with guidance from OAQPS, are to evaluate and approve various models on a case by case basis. For an air quality model to qualify as a candidate for use in a regulatory attainment demonstration, a State is required to show that it meets the following general criteria:

1. The model has undergone scientific peer review;
2. The model can be demonstrated to be applicable to the problem on a theoretical basis;
3. The data bases which are necessary to perform the analysis are available and adequate;
4. Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates;
5. The model and its source code are readily available in the public domain at little or no cost, and are not proprietary; and
6. A protocol on methods and procedures has been established.

Seigneur et al. (1997) and ENVIRON (2001b) reviewed the leading episodic and long-term (annual) Eulerian PM models, and have judged each by their technical rigor and capabilities for developing SIPs for fine PM. Here we briefly summarize these reviews, detail the important capabilities and limitation of the three leading models applicable to Boise, relate them to the six EPA criteria above, and provide an argument for the selection of a single modeling platform. The basis of our selection focuses on the applicability of the model to the episodic conditions of Northern Ada County.

The leading Eulerian PM models identified by ENVIRON (2001b) are described in Table 3-1, along with areas where they have been run specifically for PM applications. This table separates the models into two groups: reduced form and full science. The characteristics of the two are described below. ENVIRON staff are intimately familiar with many of these modeling systems, either as chief or co-developers, as users, and/or as evaluators in independent peer-review projects. These include UAM-LC, UAM-AERO/LT, UAM-AERO, REMSAD, SAQM, Models-3/CMAQ, and CAMx.

3.1.1 Reduced Form PM Chemistry

This class of PM model is characterized by the following chemical attributes:

- Gas-phase chemistry, which converts gaseous precursors to sulfate, nitrate, and condensable organics, is either empirically parameterized, or explicitly modeled using a standard photochemical mechanism such as Carbon Bond IV (CB4);
- Heterogeneous (e.g., aqueous-phase) chemistry, which converts gaseous precursors to sulfate, is empirically parameterized based on the presence of clouds or very high humidity (no heterogeneous chemistry is performed for nitrates or organics);

Table 3-1. Summary of leading Eulerian PM models.

Model	Chemistry	Features	Design Focus	Areas Applied	Applications
Reduced Form Chemical Mechanisms					
UAM-LC	Gas: Empirical Thermo: Empirical Hetero: Empirical	PM size: unresolved non-evolving (PM_{10}) Deposition: dry	Urban, Annual	Los Angeles, Phoenix	LA SIP Phoenix SIP
UAM-AERO/LT	Gas: CB4 Thermo: empirical Hetero: empirical	PM size: Pseudo-resolved non-evolving ($PM_{2.5}$, PM_{10}) Deposition: dry	Urban, Episodic-Annual	Los Angeles	LA SIP
REMSAD	Gas: Micro-CB4 Thermo: empirical Hetero: empirical	PM size: Pseudo-resolved non-evolving (species- dependent) Deposition: dry + wet Grid nesting	Regional-continental, Seasonal-annual	Continental U.S., Eastern U.S., Western U.S.	Regional Haze
CAMx	Gas: CB4 Thermo: empirical Hetero: empirical (AERO/LT)	PM size: Pseudo-resolved non-evolving (species-dependent) Deposition: dry + wet Grid nesting	Urban-regional, Episodic-annual	None	
Full Science Chemical Mechanisms					
UAM-AERO	Gas: CB4, SAPRC Thermo: SEQUILIB Hetero: empirical	PM size: resolved (sectional) Deposition: dry	Urban, Episodic	Los Angeles, San Joaquin Vly, Salt Lake City	SLC SIP
SAQM-AERO	Gas: CB4, SAPRC Thermo: SEQUILIB Hetero: empirical (UAM-AERO)	PM size: resolved (sectional) Deposition: dry + wet Grid nesting	Urban-regional, Episodic	San Joaquin Vly, Southern Calif	
URM	Gas: SAPRC Thermo: ISORROPIA Hetero: empirical	PM size: resolved (sectional) Deposition: dry + wet Grid nesting	Urban-regional, Episodic	Southeast U.S.	Regional Haze
DAQM2	Gas: RADM Thermo: MARS Hetero: explicit	PM size: resolved (modal) Deposition: dry + wet	Urban-regional, Episodic	Denver	
Models-3/CMAQ	Gas: CB4, RADM, SAPRC Thermo: MARS Hetero: explicit	PM size: resolved (modal) Deposition: dry + wet	Urban-regional, Episodic	Eastern U.S., Western U.S.	Regional Haze
CAMx	Gas: CB4, SAPRC Thermo: ISORROPIA Hetero: explicit	PM size: resolved (sectional), Deposition: dry + wet Grid nesting	Urban-regional, episodic	None	

"Gas": refers to the methodology to calculate photochemistry and/or gas-phase PM formation.
"Thermo": refers to the methodology to calculate thermodynamic equilibrium of condensable/volatile aerosols (nitrates, ammonia, organics).
"Hetero": refers to the methodology to calculate heterogeneous (i.e., aqueous-phase) sulfate formation.
"PM size": refers to the methodology to treat aerosol size distributions
"Deposition": refers to whether dry and/or wet deposition algorithms are available.

- Aerosol thermodynamics, which dictate the amount of condensed nitrate andorganics, are empirically parameterized based on local environmental conditions and the relative loading of sulfate, total nitrate, total ammonia, and condensable organics;
- Evolution of PM size distributions is not treated, and a single fixed distribution (or one specified for each aerosol species) is assumed to exist throughout the model run.

The UAM-LC model has been applied at urban scales for both episodic and annual SIP demonstrations in Phoenix and Los Angeles. The use of such a model for Phoenix was deemed appropriate due to the heavy burden of primary PM (especially fugitive dust) and relatively low contributions from secondary aerosols. However, secondary PM has been a major factor for Los Angeles, and the UAM-LC reduced form chemistry model has been mainly used for annual simulations because of speed in execution. These applications have utilized the UAM as the core transport model, a system that by today's modeling standards is considered outdated and obsolete. It has been shown that the UAM is not strictly mass conservative nor consistent (i.e., pollutant mass can be arbitrarily created or destroyed by non-physical and numerical processes).

The South Coast Air Quality Management District in Southern California is planning to use UAM-AERO/LT in concert with other models for the next round of PM SIP air quality modeling. The AERO/LT is a hybrid of the full-science UAM-AERO approach and the UAM-LC empirical PM chemistry/thermodynamics package. Like UAM-AERO, AERO/LT contains the CB4 to simulate photochemistry and the gas-phase production of sulfate, nitrate, and organics. Like UAM-LC, the AERO/LT approach continues to use empirical heterogeneous chemistry and thermodynamics, and does not contain a PM size evolution model.

CAMx is a state-of-the-science photochemical model that has been used in manySIPs for ozone throughout the country for several years. It has been used in the OTAG process to evaluate the NOx SIP call regulations, and it is currently being evaluated against Models-3/CMAQ in several areas in California. As a newer model, it does not rely on "legacy" program code and the transport routines are carefully written to preserve mass conservation and consistenty. This model allows for two-way grid nesting. CAMx contains the CB4 and SAPRC99 chemical mechanisms for photochemistry and gas-phase projection of sulfate, nitrate, and organics. The model also contains an improved version of the AERO/LT approach as the reduced form PM option for heterogeneous sulfate production, and to partition sulfate, nitrate and ammonium. With the AERO/LT option, CAMx does not provide a time-dependent PM size evolution model, but does allow the user to specify species-dependent PM size and density (i.e., as in an "external" aerosol mixture).

REMSAD was designed specifically to treat seasonal to annual distributions of PM across large portions of the country (or continent) for the purposes of regional haze, toxics, and deposition analyses. As such, it is formulated with a condensed version of the CB4 gas-phase chemistry mechanism to increase speed, and it contains relatively simple reduced form PM chemistry and thermodynamics. The simplifications in its chemistry treatment were partially based on the premise that the REMSAD grid would be coarse ($\sim$10-80 km) due to its potential continental-scale coverage. Therefore, REMSAD is not an appropriate model to use for urban-scale PM SIP modeling, especially if secondary species are an important fraction of the total burden.

3.1.2 Full Science PM Chemistry

This class of PM model is characterized by the following chemical attributes:

- Gas-phase chemistry, which converts gaseous precursors to sulfate, nitrate, and condensable organics, is explicitly modeled using a standard photochemical mechanism such as Carbon Bond IV (CB4);

- Heterogeneous (e.g., aqueous-phase) chemistry, which converts gaseous precursors to sulfate is either empirically parameterized, or explicitly calculated (no heterogeneous chemistry is performed for nitrates or organics);
- Aerosol thermodynamics, which dictate the amount of condensed nitrate andorganics, are explicitly calculated; and
- Evolution of PM size distributions is treated using a size-segregation or modal-based sub-model for each aerosol species.

These full science PM models are considered state-of-the-science by incorporating the latest theories and modules to simulate the chemistry of PM formation and fate. Most run on regional scales to properly capture the buildup of secondary PM in an area of interest. The use of explicit treatments for almost all chemical processes often leads to runtimes that exceed real time (i.e., they can take longer than 24 hours of CPU time to simulate a single day), due to the hundreds of numerically "stiff" differential equations that must be solved.

Many of these platforms were originally designed for PM SIP modeling of specific areas of the country. The UAM and SAQM/DAQM series of models have been developed and applied for much of California (San Joaquin Valley, Los Angeles), and the intermountain west (Salt Lake City, Denver). Significant resources have been expended to develop UAM-AERO, SAQM-AERO, and DAQM. Unfortunately, they have yielded significant performance problems in almost every regulatory application, and as a result they have been ignored in all SIP documentation to date in favor of estimates from simpler approaches (linear rollback in the San Joaquin Valley, and UAM-LC in Los Angeles). Recent SIP applications of UAM-AERO in Salt Lake City have also indicated performance problems, especially for aerosol nitrate. In all cases, poor performance is related to: (1) a lack of full understanding of the very complex interactions and feed-backs produced by these models; (2) the requirement of many additional inputs required to accurately characterize the state of the environment, particularly for clouds; (3) the increased level of ambient detail needed by these models, which are not easily obtained by today's meteorological/emissions models or observational networks (e.g., exact location of clouds, cloud liquid water content, and PM speciation/size profiles); and (4) the need for additional assumptions when the requirements of (3) cannot be met, as the science is often beyond the practical resources of the model users.

To date, models such as URM and Models-3/CMAQ have only been utilized for regional haze studies; the former is considered primarily an academic platform, while the latter has been used mostly for regional ozone and visibility modeling. Finally, some of these types of models are difficult to apply outside the areas for which they were originally designed (e.g., SAQM-AERO in California, DAQM2 in Denver, and URM in the southeast). The reasons for this include: hard-coded domain definitions and nested grid configurations; use of specific meteorological databases that were developed over several years; and chemical mechanisms designed for the specific areas.

3.1.3 Inter-Comparison of Top Three Platforms

This section provides a more in-depth comparison of the top three full science PM modeling platforms listed in Table 3-1. The purpose of this is to provide a better understanding of these models so as to come to a more educated decision on model selection. In terms of portability, we consider the top three full science Eulerian PM models applicable to the Boise area to include UAM-AERO, CMAQ, and CAMx. As stated above, the other platforms are difficult to utilize outside the types of applications for which they were developed, or they have had a history of significant performance problems that render them ineffective.

UAM-AERO

UAM-AERO (Kumar and Lurmann, 1996) was developed specifically for PM SIP development activities in California's South Coast Air Basin (SoCAB, or the Los Angeles Basin). It includes state-of-the-science algorithms for photochemistry and gas-phase PM formation (CB4 and SAPRC), aerosol thermodynamics (SEQUILIB), and a fully resolved sectional model to treat the evolution of PM size distributions. It includes species for sulfate, nitrate, organics, and treats the interactions with sea salt as well. At the time it was developed for southern California, it contained an empirical aqueous-phase module for sulfate, in which the presence of clouds is provided externally (either maritime stratus is present in the basin, or it is clear), and gas-phase sulfate formation rates are simply increased as a function of ambient relative humidity. Originally, UAM-AERO did not contain a wet deposition capability. These treatments may have been upgraded to a more explicit aqueous treatment for applications in Salt Lake City.

The disadvantages of UAM-AERO include: (1) the use of the original UAM transport code as the base model; and (2) the "real time" CPU required to make a multi-day run. As for (1), the UAM structure is obsolete, and leads to mass conservation and consistency errors (as described above). Its reliance on the "diffusion break" as a means to describe mixing gradients in the vertical is incorrect and is a major factor associated with the mass problems. The time- and space-varying vertical grid structure does not allow for input meteorology to be directly translated from the meteorological grid to the air quality grid without major interpolation, averaging, and "divergence minimization" steps that can drastically alter the input wind fields. UAM-AERO can only be run on a UTM grid. It is conceivable that the technical gains afforded in the incorporation of full science PM chemistry are likely obscured to some extent by the inadequacies associated with UAM dispersion.

Past UAM-AERO base-year performance in the SoCAB has been considered to be marginal to good, but runtimes for this model were sufficiently long that the South Coast Air Quality Management District (SCAQMD) could not utilize UAM-AERO for all of the control measure runs needed for their latest PM SIP for the SoCAB. Instead, annual PM reductions simulated by UAM-LC were applied to the individual episodes in the final SIP demonstration. The SCAQMD intends to further apply the UAM-AERO/LT for its latest round of SIP modeling. Furthermore, after UAM-AERO had failed in base-year applications for the San Joaquin Valley, results from speciated roll back calculations were ultimately used to support the PM SIP for that region. The UDEQ used UAM-AERO to support the Salt Lake City area PM SIP. Over a year was spent in attempting to improve UAM-AERO performance to acceptable levels via modifications to the model and to the meteorological inputs. The major concern at the time involved problems in replicating aerosol nitrate (Barickman, UDEQ, personal communication). A similar environment for aerosol nitrate appears to exist for Boise, and UAM-AERO could be unsatisfactory there as well.

CMAQ

The Models-3/CMAQ (Byun and Ching, 1999) is the chemical-transport component of the EPA's Models-3 system, which comprises complex meteorological, emissions, chemistry/transport, and evaluation processors in a single package. The Models-3 system has been developed by the ORD of EPA with the intent of providing a fully state-of-the-science modeling system to the air quality planning community. EPA's goal is that the community at large will ultimately provide future development activities to upgrade various components of the system as needed. With photochemical and PM capabilities at many scales, from individual point sources to regional air quality trends, Models-3 is being heralded as the future de-facto modeling system to be used for all regulatory air quality analyses.

CMAQ provides several options for photochemistry and gas-phase PM formation, including CB4, RADM, and SAPRC. It utilizes the MARS approach for thermodynamic equilibrium, and includes an explicit aqueous-phase algorithm to estimate in-cloud production of sulfate as a function of cloud parameters, assumed dissolved metals, and available peroxide. The PM size distribution model is formulated for a modal approach (analytical functions of size distribution), and CMAQ includes both dry and wet deposition.

When model selection for Boise was underway, the CMAQ required the use of the Models-3 version of MM5 to supply meteorological input fields. The Models-3/MM5 is an older version of the publicly available meteorological model from NCAR that has been specifically altered/configured to provide inputs to CMAQ. This version of MM5 must be run on the same grid extent and resolution to be used for CMAQ, thereby requiring that both models be run on the MM5 Lambert Conic Conformal mapping projection. The MM5 output is then pushed through the MCIP preprocessor before being supplied to CMAQ. This preprocessor extracts the specific meteorological fields to be used by dispersion model and performs a dynamic readjustment to the wind and thermodynamic fields to improve mass consistency. We understand that this process can potentially alter the wind fields that are eventually supplied to CMAQ.

The most straightforward approach for developing emission inputs for CMAQ is to use the Models-3 processor called SMOKE. At the time of model selection, SMOKE was not entirely available for ozone or PM applications, and it possessed limited QA/QC features. It also produced emissions on a Lambert Conformal projection to match CMAQ. A system like EPS2 can be used to prepare PM and precursor emissions for CMAQ on a Lambert projection, but an interface processor must be developed and applied to translate EPS2 output to CMAQ NetCDF data archive formats (referred to as IO/API).

To date, CMAQ has not been utilized in any SIP-related activities. Some regional haze studies have been performed, however (e.g., WRAP). Early indications are that continental-scale applications of CMAQ have resulted in aerosol nitrate predictions that are worse than the relatively poor performance exhibited by the much simpler REMSAD model (a reduced form PM model). The reasons for this were unknown at the time of model selection (Timin, EPA/OAQPS, personal communication).

CAMx

CAMx (ENVIRON, 2002) is a peer-reviewed (for ozone) nested-grid photochemical model that is currently being used in several areas for the development of ozoneSIPs. As one of three widely used state-of-the-science photochemical models, its technical formulation for gas-phase chemistry (secondary PM) and dispersion is on par with CMAQ. The transport numerics in CAMx have been designed for mass conservation and consistency, and three options for horizontal advection solvers are available on four types of map projections (UTM, Lambert Conformal, Polar Stereographic, and geodetic).

At the time of model selection, CAMx contained an improved version of the reduced form AERO/LT aerosol package, which utilizes sulfate, nitrate, and organic carbon products from CB4 for the secondary PM. This version of CAMx includes empirical relationships for aqueous-phase sulfate and aerosol thermodynamics, but it does not include a time-evolving size model. Instead, the model allows the user to provide species-dependent size and density. Since the AERO/LT approach is to be used for the next PM SIP effort in southern California, the SCAQMD is planning an evaluation of the performance of this reduced form option in CAMx.

CAMx has since been upgraded with a set of full science PM modules to include: the ISORROPIA aerosol thermodynamic algorithm, a new explicit aqueous-phase model, and an improved sectional size evolution model. The development of the full science CAMx is sponsored by the Coordinating Research Council (CRC), which in separate studies (Strader et al., 1998; Zhang et al., 1998, 1999) has recommended these specific modules for their technical advancements over the current full science modules available in UAM-AERO and CMAQ. Incorporation of these improvements was just recently completed and CAMx is currently undergoing testing. The use of the full science PM algorithms in CAMx leads to runtimes that are equivalent or slightly slower than those in UAM-AERO or CMAQ.

One disadvantage of CAMx is that it had not been utilized or demonstrated for any regulatory PM applications prior to the model selection for Boise, whether for urban-scale PMSIPs or for regional haze analyses. Also, the combination of CAMx with the improved AERO/LT package had not been peer-reviewed. However, the AERO/LT chemistry had been evaluated for episodic conditions in Los Angeles (Morris et al., 1998), and the full science components had been reviewed, evaluated, and recommended in CRC-sponsored research.

3.2 CONSIDERATIONS FOR THIS PROJECT

A summary of the major points raised in this review include:

- To date, only reduced form Eulerian PM models have been used in some SIPs (most rely on estimates from ISC and speciated rollback);
- Many areas have shelved results from their full science SIP models after difficulties in rectifying poor performance stressed costs and schedule;
- The UDEQ has applied UAM-AERO for the Salt Lake City PM_{10} SIP, but they too experienced performance problems (although this could be as much a problem with the

UAM itself as with the full science modules) – these problems pointed to potential timing issues for the Boise SIP;

- Evidence suggests that nitrate and, to a lesser extent, sulfate comprise a sizeable fraction of PM_{10} in Northern Ada County, and that formation could be via nighttime and heterogeneous pathways in the cold, foggy, short-duration/low-intensity sunlight conditions of wintertime stagnation episodes – processes that no full science models have demonstrated they can handle;
- While full science models offer much more advanced technical capabilities, they are not necessarily the best approach given all considerations; and
- It is much easier to justify and make modifications (if necessary) to the parameterizations of a reduced form model than to the explicit physical equations of a full science model.

The final consideration for this project was the extent to which the top three full science modeling platforms identified here meet the six acceptance criteria set forth by the EPA. The following table summarizes the status of these models at the time of model selection:

EPA Criteria	UAM-AERO	CMAQ	CAMx
1. Scientific Peer Review	√	√	√[1]
2. Applicable on a theoretical basis	√	√	√
3. Adequate data bases are available[2]	√	√	√
4. No consistent underestimate bias[3]			
5. Not proprietary, public-domain	√	√	√
6. Established application protocol	√	√	√

Notes:

1. Whereas CAMx with the reduced-form PM model has not undergone peer review per se, the host CAMx photochemical transport model has undergone peer review as an ozone model, and the AERO-LT and full science PM modules have undergone peer review individually.
2. The Ada/Canyon County PM_{10} and meteorological databases are marginally adequate for the operation and evaluation of full science models – episodic speciated filter data are available for both 1991 and 1999 episodes modeled in this study, but size-resolved data (other than 2.5/10 splits in 1999) are unavailable.
3. Currently, no full science PM model can sufficiently demonstrate unbiased performance; in the cases of CMAQ and CAMx, they had not been applied in any comprehensive PM evaluations at the time of model selection to make a judgement in this regard.

3.2.1 Selected Approach

We selected CAMx with the improved reduced form AERO/LT chemistry for the Ada County PM_{10} maintenance modeling. The reasons are as follows:

- No full science model had demonstrated adequate performance for SIP modeling without large investments of resources, all of which far surpassed the schedule and scope available for the Ada County demonstration.
- Since the original plan called for both episodic and annual modeling to be performed, a single model applicable to both time scales was seen as a way to provide a consistent approach, while the faster chemistry solution in a reduced form model strikes an optimal balance between technical rigor, the tight project schedule, and available resources.
- The use of the CB4 mechanism for gas-phase secondary PM chemistry is better than an empirical approach. The AERO/LT methodology (available in both UAM and CAMx) has been evaluated for Los Angeles Basin with good results (ENVIRON, 2001b).
- UAM-based transport models, with their use of "diffusion break", do not appropriately resolve processes in the vertical, are not mass consistent, contain simplistic dynamics, and do not include wet deposition, which may be important in these applications; CAMx includes all new coding and transport algorithms (for mass conservation and consistency), is well established for ozone SIP modeling throughout the country, and includes wet deposition.
- CAMx allows input environmental data from any mix of meteorological models, which is not possible with CMAQ. At the time of model selection, a flexible approach was considered necessary to adequately characterize wind fields in Boise.
- EPS2 was used to develop the Boise PM emissions inventory; whereas CAMx uses data directly from that system, it would have been necessary to perform additional I/O translation for CMAQ.
- CAMx affords a capability to perform reduced form and full science PM simulations using a single host modeling platform, and this allows for a direct comparison of the two approaches rather than introducing a separate modeling system that utilizes different transport, diffusion, removal, and chemistry, and/or completely different input requirements.

The IDEQ and EPA concurred with the selection of CAMx because it provides a good balance between the technical requirements of the study and the tight cost/schedule constraints. The reduced form and full science options are equivalent to, or improvements beyond, the UAM-AERO/LT and UAM-AERO versions, respectively. This means that CAMx provides an equal or better capability for PM chemistry, but without the drawbacks of the obsolete and inaccurate UAM transport code.

4.0 MODELING DOMAIN

The spatial domain (or volume) on which Eulerian air quality models operate is defined as a three-dimensional grid that is used to discretize the atmosphere into many grid cell volumes. The modeling grid should be defined with sufficient extent and resolution to capture all of the emissions and physical processes that affect pollutant concentration patterns in the particular focus area. Obviously a balance must be struck between grid size and resolution, both because of resource constraints (budget, schedule, and computing power), and because of limitations inherent in most Eulerian models to characterize physical phenomena at small scales below 1 km horizontally.

Past studies have developed gridded databases for the Treasure Valley, including 1995 emission estimates on a grid of 1-km cells (SAI, 1997), and air quality modeling with WYNDvalley (Koracin, 1998) on a subset of the 1-km emissions grid. The 1995 emissions grid covered northern Ada County and most of Canyon County, spanning about 90-km east-west and about 50-km north-south for a total of over 4500 grid cells. In the current study, updated 1999 emission estimates for the basin were developed on a 1-km grid as well, which dictated the use of a 1-km grid for the dispersion and meteorological modeling. The past emission and Eulerian modeling grids were defined on a Universal TransverseMercator (UTM) mapping projection; the same approach was defined for this study[1].

The WYNDvalley model utilized a simple 4-layer approach to define the depth of the modeling domain, where each layer was 26 m thick, resulting in a total domain depth of 104 m. WYNDvalley is not a terrain-following model, so the terrain surrounding the valley acts as a barrier to horizontal flow; therefore, WYNDvalley can only be applied to the area covered by the valley floor. Furthermore, WYNDvalley limits the total allowable number of grid cells to be used in a simulation, which necessitated a relatively small domain extent in the past exercises. All models employed in the current study are formulated in terrain-following coordinates, defined by the topology of the underlying terrain, and posses no internal limits on the total number of grid cells. The meteorological model includes the effects of terrain (e.g., blocking, acceleration over passes, upslope and drainage flows, etc.) in simulating the evolution of wind and hydrodynamic fields.

4.1 HORIZONTAL STRUCTURE

The spatial extent of the CAMx 1-km horizontal modeling grid is shown in Figure 4-1. Tick marks on the axes indicate the size of each 1-km grid cell. The east-west extent of the domain is similar to the 1995 emissions grid, but the north-south extent is increased in both directions to more fully capture the diurnal and multi-day movement of PM and precursors up- and down-valley during stagnation events. Once pollutants exit the modeling domain through the boundaries they cannot be recovered in the event of a wind reversal. If the domain is too

[1] While a UTM mapping projection was used for emissions and dispersion modeling, the MM5 meteorological modeling required a Lambert Conformal projection. Therefore it was necessary to map the meteorological fields to the dispersion modeling grid to develop the necessary inputs for CAMx. This process is described in Section 5.

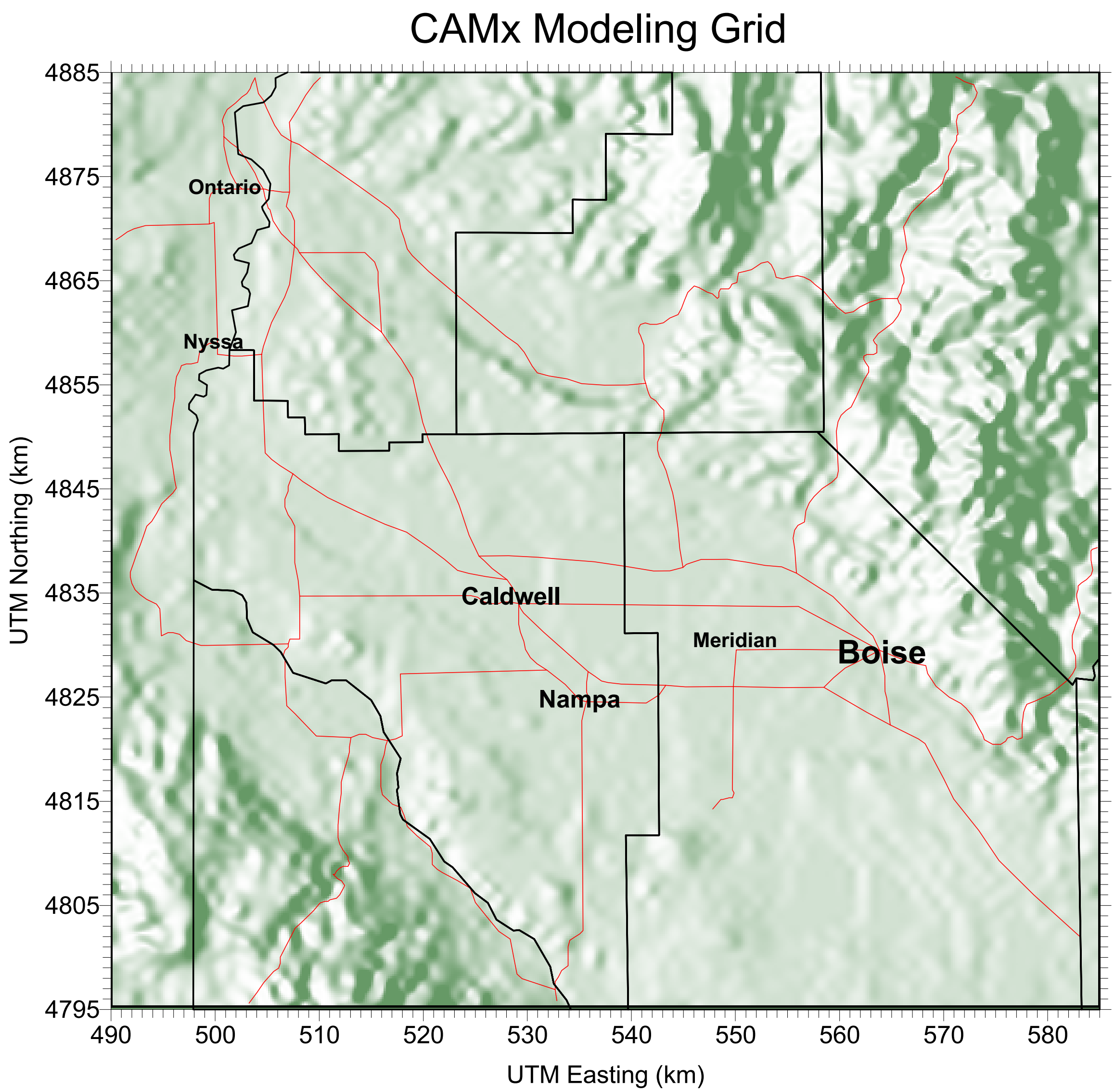


Figure 4-1. The coverage of the CAMx and finest MM5 modeling domain. Tick marks on the axes represent the size of 1-km grid cells. Black lines denote county boundaries and red lines show major highways. Overall domain size is 95 by 90 km.

small, significant amounts of mass could be lost day-to-day when in reality they recirculate into the basin as winds reverse. It is also better to include all potential emission sources in the area of interest rather than relying on boundary conditions to specify flux into the domain. This is particularly an issue in the northwestern portion of the domain, which includes the I-84 corridor into Ontario, Oregon, and some additional large industrial facilities. A domain of this size required emission estimates from the surrounding counties (which were not included in the methodology outlined in the Emission Inventory Preparation Plan); the procedures to include these inputs are described in the Emissions Inventory report. Figure 4-1 also represents the size and resolution of the MM5 1-km nested grid (the specifics of the MM5 modeling grids are described in the supplementary Meteorological Modeling report).

4.2 VERTICAL STRUCTURE

The Modeling Protocol suggested that the domain depth for the CAMx applications should be deeper than 100 m to ensure that all of the relevant physical processes in the vertical are fully resolved and properly treated; these include resolved subsidence (sinking) of air over the basin, and hourly variations in vertical diffusion. A domain depth of at least 1000 m was suggested for episodic conditions, and further analysis of rawinsonde data and meteorological model results were evaluated to confirm this (see the supplementary Meteorological Modeling report). Several layers were needed to resolve stratifications near the surface (within 100 m) and additional layers were used aloft to handle temperature gradients and wind shears that affect vertical mixing and transport. Multiple layers were also necessary to treat the transport and chemistry of elevated point source plumes. At total of ten layers were defined for CAMx that span from the surface to about 1500 m.

From the meteorological modeling standpoint, the MM5 must be run for the entire troposphere (~16-km depth) so that large scale dynamics of the atmosphere are properly simulated. This is particularly important so that MM5 can simulate the stagnation and large-scale subsidence that occur during PM episodes. The MM5 vertical layer structure was defined to match the CAMx structure in the lower troposphere, and added many additional layers to the top of the troposphere. The MM5 and CAMx vertical layer structures defined for this study are illustrated in Figure 4-2.

k	sigma	pressure	height	thickness	CAMx Layers
26	0.0000	100.00	15675.96	2004.22	
25	0.0500	145.00	13671.75	1584.98	
24	0.1000	190.00	12086.77	1321.62	
23	0.1500	235.00	10765.15	1139.09	
22	0.2000	280.00	9626.06	1004.34	
21	0.2500	325.00	8621.72	900.35	
20	0.3000	370.00	7721.37	817.43	
19	0.3500	415.00	6903.94	749.61	
18	0.4000	460.00	6154.33	693.00	
17	0.4500	505.00	5461.32	644.98	
16	0.5000	550.00	4816.34	603.67	
15	0.5500	595.00	4212.67	567.73	
14	0.6000	640.00	3644.94	536.15	
13	0.6500	685.00	3108.79	508.15	
12	0.7000	730.00	2600.64	483.15	
11	0.7500	775.00	2117.49	460.68	
10	0.8000	820.00	**1656.81**	440.36	--10---
9	0.8500	865.00	**1216.45**	338.91	---9---
8	0.8900	901.00	**877.55**	246.93	---8---
7	0.9200	928.00	**630.62**	161.35	---7---
6	0.9400	946.00	**469.27**	158.83	---6---
5	0.9600	964.00	**310.44**	117.52	---5---
4	0.9750	977.50	**192.92**	93.05	---4---
3	0.9870	988.30	**99.87**	53.89	---3---
2	0.9940	994.60	**45.97**	23.27	---2---
1	0.9970	997.30	**22.70**	22.70	---1---
0	1.0000	1000.00	**0.00**	=================Surface======	

Figure 4-2. The MM5 vertical grid structure based on 26 normalized pressure (sigma-p) levels, including the surface. Heights (m) are above sea level according to a standard atmosphere; pressure is in millibars. Heights scale by terrain altitude according to the terrain following coordinate system. The right side of the figure indicates the levels mapped to the CAMx modeling domain (heights shown in bold).

5.0 CAMx INPUT DATA PREPARATION

The CAMx dispersion model was configured to run with the AERO/LT reduced form PM chemistry algorithm to simulate the emissions of primary PM and precursors, in-situ secondary chemical production, and transport of PM in the Treasure Valley. The model utilized gridded meteorological inputs developed from the MM5 model (described in the supplemental Meteorological Modeling report), along with 1999 and future year gridded emission inputs (described in the companion Emissions Inventory report). This section describes the translation of meteorological fields from MM5 to CAMx, the preparation of ancillary CAMx inputs, and the selection of various model options. Appendix A provides a description of the data that were procured from various sources to develop the meteorological and air quality input/evaluation databases.

5.1 PREPARATION OF METEOROLOGICAL INPUTS

CAMx requires meteorological input data for the parameters described in Table 5-1. All of these input data were derived from MM5 simulations on a 1-km modeling grid similar to that used by CAMx. However, the MM5 mapping projection was Lambert Conformal, while the CAMx projection was UTM. As described in the supplemental Meteorological Modeling report, the MM5 grid was specified to align with the UTM grid as closely as possibly to minimize mapping distortion between the two projections. Another necessary task was to extract data from a subset of MM5 vertical layers to the CAMx grid. The translation of MM5 output fields to CAMx-ready inputs was accomplished using ENVIRON's MM5CAMx translation software. The accuracy of this process was verified from reviewing information echoed by the translator, and by comparing graphics of CAMx-ready meteorological fields with plots of MM5 variables.

Table 5-1. CAMx meteorological input data requirements.

CAMx Input Parameter	Description
Layer interface height (m)	3-D gridded spatially-varying layer heights for the start and end of each hour
Winds (m/s)	3-D gridded horizontal wind components (u,v) for the start and end of each hour
Temperature (K)	3-D gridded temperature and 2-D gridded surface temperature for the start and end of each hour
Pressure (mb)	3-D gridded pressure for the start and end of each hour
Vertical Diffusivity (m^2/s)	3-D gridded vertical exchange coefficients for each hour
Water Vapor (ppm)	3-D gridded water vapor mixing ratio for each hour
Cloud Cover	3-D gridded cloud cover for each hour
Rainfall Rate (in/hr)	2-D gridded rainfall rate for each hour

The MM5CAMx program performs several functions:

1. Extracts data from MM5 grids that cover the corresponding CAMx grid; performs a mass-weighted horizontal interpolation of data from the MM5 grid to the CAMx grid in cases where the MM5 is run at different resolution than CAMx (not applicable in this case), and/or MM5 is operated on a different mapping projection (as in this case);
2. Performs mass-weighted vertical aggregation of data for CAMx layers that span multiple MM5 layers (not applicable in this case as each CAMx layer mapped directly to a corresponding MM5 layer);
3. Diagnoses key variables that are not directly output by MM5 (i.e., vertical diffusion coefficients);

The MM5CAMx program has been written to carefully preserve the consistency of the predicted wind, temperature and pressure fields output by MM5. This is the key to preparing mass-consistent inputs for CAMx, and therefore minimizing modeling uncertainty that can arise from translating data fields from one model to another. Another way CAMx ensures mass conservation (and consistency) is to internally calculate the distribution of the vertical wind component from the inputs of the horizontal wind components. Vertical wind components are not taken directly from MM5.

In all of the developmental 1999 base case simulations described in Section 6, meteorology from MM5 “Run 3” was processed using MM5CAMx (see the supplementary Meteorological Modeling report for a description and review of this and other MM5 output used for CAMx simulations). Additional sensitivity tests were conducted for the base case episode using an alternative realization of meteorology from MM5 “Run 4”. For all future year simulations based upon January 1991 meteorology, a single set of MM5 results from “Run 11” were used.

The data fields modeled by MM5 were directly input to CAMx with the exception of the vertical diffusivity coefficients (Kv), which were diagnosed from other variables such as vertical gradients of temperature and wind, boundary/mixed layer depths, and turbulent kinetic energy. Vertical diffusivities are an important input to the CAMx simulation since they determine the rate and depth of mixing in the planetary boundary layer (PBL) and above. In general, our experience has been that diffusivities from meteorological models require careful examination before they are used in air quality modeling. This may be because the air quality model results are much more sensitive to diffusivities than the meteorological model results. In fact, MM5 does not provide outputs of diffusivities. We have evaluated the CAMx diffusion inputs by comparing several calculation approaches, and by analyzing available sounding data from the local rawinsonde (see the supplemental Meteorological Modeling report).

Two approaches were used to calculate gridded diffusivity inputs, depending on the way MM5 was configured for the 1991 and 1999 episodes. Most of the developmental CAMx applications for the December 1999 base case performance evaluation utilized MM5 simulations configured with the Gayno-Seaman boundary layer option. This option provides output of turbulent kinetic energy (TKE) fields, which can be directly used to define the values of vertical diffusivity, known as the TKE method (Mellor and Yamada, 1982; Helfand and Labraga, 1991). We feel that this is the best overall approach for the meteorological model, and for diagnosing diffusivities in the air quality model.

The TKE method is a pseudo-second order closure method in which turbulent energy is a prognostic variable carried by MM5 much like winds, temerpatures, etc. (Mellor and Yamada, 1982). Indeed, turbulent energy is produced, transported, diffused, and decayed similarly to the other forecast variables. The method to calculate diffusivities (*Kv*) from TKE ($q^2/2$) is:

$$Kv = S_h \, l \, q$$

where l is mixing length. For unstable conditions (as determined by the bulk Richardson number *Ri*), l is given by

$$l = \frac{kz}{1 + \frac{kz}{x_\infty}}$$

wheras for stable conditions it is

$$l = \min\left[l, 0.75 \frac{q}{(RiS)^{1/2}} \right]$$

where S is local wind shear, k is von Karman's constant (0.4), z is height above ground (m), and x_∞ is the free-atmosphere mixing length. The parameter S_h is a stability coefficient for heat and is parametrically calculated for growing and decaying turbulence cases separately. Both x_∞ and S_h are determined from relationships developed by Helfand and Labgraga (1991).

Alternatively, the meteorological simulation of the January 1991 period, and later test runs for the December 1999 episode, used the Medium Range Forecast (MRF) boundary layer option. In this case, MM5 only provides boundary/mixed layer heights, and so no specific knowledge is available about the magnitude of mixing within that depth. Therefore, it was necessary to diagnose vertical diffusivities from available output. The method chosen for the MRF runs was based on the approach of McNider and Pielke (1981), which defines diffusivity as functions of local temperature and wind gradients separately for unstable, neutral, and stable conditions.

In this approach, *Kv* is calculated from layer-by-layer shear and temperature gradients. Above the critical Richardson number (*Ric*), which defines a very stable regime, *Kv* is set to the minimum value of 0.1 m^2/s. In mechanically mixed conditions ($0 < Ri < Ric$), diffusivity is calculated from

$$Kv = 1.485 l^2 S \frac{Ric - Ri}{Ric}$$

In unstable conditions ($Ri < 0$), diffusivity is

$$Kv = 1.35 l^2 S (1 - 18 Ri)^{1/2}$$

The component that differentiates the McNider and Pielke (1981) approach is the calculation of mixing length, which is specifically tuned to the depth of the well-mixed boundary layer in unstable conditions; it is set to the standard profile of $l = \min(kz, 70)$ in stable conditions and above the boundary layer. The procedures described above have been developed, and are currently being used, in several ozone SIP modeling exercises. An inter-comparison of the effects of these approaches on base case performance is described in Section 6.

5.2 DEVELOPMENT OF ANCILLARY INPUTS

Besides emissions and meteorological inputs, CAMx requires several other input datasets to fully describe the environment in which to perform the simulation. These include initial and boundary conditions, definition of the surface characteristics, and atmospheric radiative properties. The initial conditions (ICs) are the pollutant concentrations specified throughout the modeling domain at the start of the simulation. Boundary conditions (BCs) are the pollutant concentrations specified around the perimeter of the modeling domain. Including several "spin-up" days prior to the key episode period allows time for the influence of initial conditions to be removed. By expanding the domain to include all potential sources surrounding Ada and Canyon Counties (particularly to the northwest), the boundary conditions have minimal impacts on the model results in this study.

5.2.1 Inital and Boundary Conditions

Table 5-2 provides a listing of clean/rural background IC/BC values for the gaseous Carbon Bond IV (CB4) species, similar to the clean values used by the Ozone Transport Assessment Group (OTAG) for regional scale modeling of the Eastern US (OTAG, 1996). These values represent continental background conditions, and were considered to be appropriate values for this study, given the lack of NOx, VOC, and ozone measurements in the area and periods modeled. The values shown in Table 5-2 were used for both initial and boundary concentrations, except NO and NO_2, for which separate IC values were supplied to characterize the higher levels expected in the domain given the rural-urban mix. Concentrations for those CB4 species not listed in the table were set to very small values automatically within CAMx (on the order of 10^9 ppm).

Data from the IMPROVE regional monitoring network were analyzed to define the boundary conditions for PM. Specifically, speciated data from the Jarbidge and Sawtooth Wilderness sites on four sampling days (December 18, 22, 25, and 29 of 1999) were evaluated, and the mean speciated concentrations from these two sites were applied uniformly (horizontally and vertically) on all four boundaries. These boundary conditions were used for the 1999 base year simulations as well as for all future year scenarios. No growth factors were applied to the boundary conditions for future years because (1) the modeling domain contains all major local sources contributing to PM_{10} in the Treasure Valley, (2) the remoteness of the domain insulates it from the effects of other anthropogenic sources in the region, and (3) the model results would be insensitive to changes in the very low ambient boundary concentrations.

Initial conditions were determined from 24-hour PM_{10} and $PM_{2.5}$ samples taken before the start of the episode as part of the DRI/IDEQ fine particulate monitoring study. Four sites operated on December 17: Boise Fire Station #5, Mountain View School, White Pine School, and

Table 5-2. Clean/rural concentration values used for the CAMx initial and boundary concentrations.

Gas Species	IC/BC Concentration (ppb)	PM Species	BC Concentration ($\mu g/m^3$)
O_3	40.0	Sulfate	0.10
NO	BC: 0.000049 IC: 0.10	Nitrate	0.03
NO_2	BC: 0.086 IC: 1.0	Ammonium	0.05
SO_2	1.0	Organic carbon	0.5
CO	100.0	Elemental carbon	0.02
PAR	3.1	Other Primary Fine	0.2
HCHO	1.1	Primary Coarse	0.2
ETH	0.0053		**IC Concentration ($\mu g/m^3$)**
ALD2	0.11	Sulfate	0.6
TOL	0.0060	Nitrate	2.4
PAN	0.038	Ammonium	0.8
HNO_2	0.00073	Organic carbon	3.8
HNO_3	1.5	Elemental carbon	1.2
H_2O_2	2.3	Other Primary Fine	1.3
NH_3	2.0	Primary Coarse	4.2

Northwest Nazarine College. No data were available on December 19, the day before the simulated episode. All four sites measured only total fine and/or 10 micron mass on that day (no speciated data were available). It was therefore necessary to estimate the speciated initial concentrations. The mean relative fine and 10 micron mass budgets from the speciated sites (Boise Fire Station # 5 and Cloverdale) were calculated over the entire December 20-26, 1999 episode. Then this mean mass budget was applied to the total fine and 10 micron mass data available on December 17, and averaged over all sites to yield a single set of representative initial concentrations. The PM initial condition values shown in Table 5-2 were applied uniformly over the entire grid.

5.2.2 Land Use Distribution

CAMx requires gridded land use data to characterize surface boundary conditions that adjust deposition rates for roughness, vegetative distribution, and water/land boundaries. Land use is also used to define the surface ultraviolet (UV) albedo, which is used to affect photolysis rates. The CAMx land use input database is more detailed than the MM5 inputs, in that CAMx requires the distribution of eleven land use categories in each grid cell, whereas the meteorological model only requires the specification of a single dominant land use category per cell. The land use categories used in CAMx are listed in Table 5-3, along with the assigned roughness lengths and UV albedo.

Table 5-3. CAMx land use categories and the default surface roughness values (m) and UV albedo assigned to each category within CAMx.

Category Number	Land Cover Category	Surface Roughness (meters)	UV Albedo
1	Urban	3.00	0.08
2	Agricultural	0.25	0.05
3	Rangeland	0.05	0.05
4	Deciduous forest	1.00	0.05
5	Coniferous forest including wetland	1.00	0.05
6	Mixed forest	1.00	0.05
7	Water	0.0001	0.04
8	Barren land	0.002	0.08
9	Non-forested wetlands	0.15	0.05
10	Mixed agricultural and range	0.10	0.05
11	Rocky (with low shrubs)	0.10	0.05

Gridded geographic data required by CAMx were translated from the GIS-based spatial surrogate files used in the processing of the emissions inventory (see Appendix A). Figure 5-1 presents the resulting land use distribution in the CAMx domain.

No attempt was made to modify the land use file for the presence of snow for applications using the 1991 meteorological episode. Only the gaseous deposition rates would have been impacted by this change, and no or very little data exist to justify the modification of various parameters within the dry deposition code.

5.2.3 Chemistry Inputs

Three input files define the chemistry used in CAMx:

1. *Chemistry Parameters*: The chemistry parameters file selects which chemical mechanism to use, specifies the rate constants and temperature dependencies for thethermochemical reactions, and sets species-dependent deposition and aerosol size parameters. CAMx was run with the Carbon Bond IV mechanism and the reduced form chemistry package, which is referred to as "Chemistry Mechanism 4" in CAMx. The final aerosol size parameters used in the Base Case performance evaluation and in all future year simulations are shown in Table 5-4.

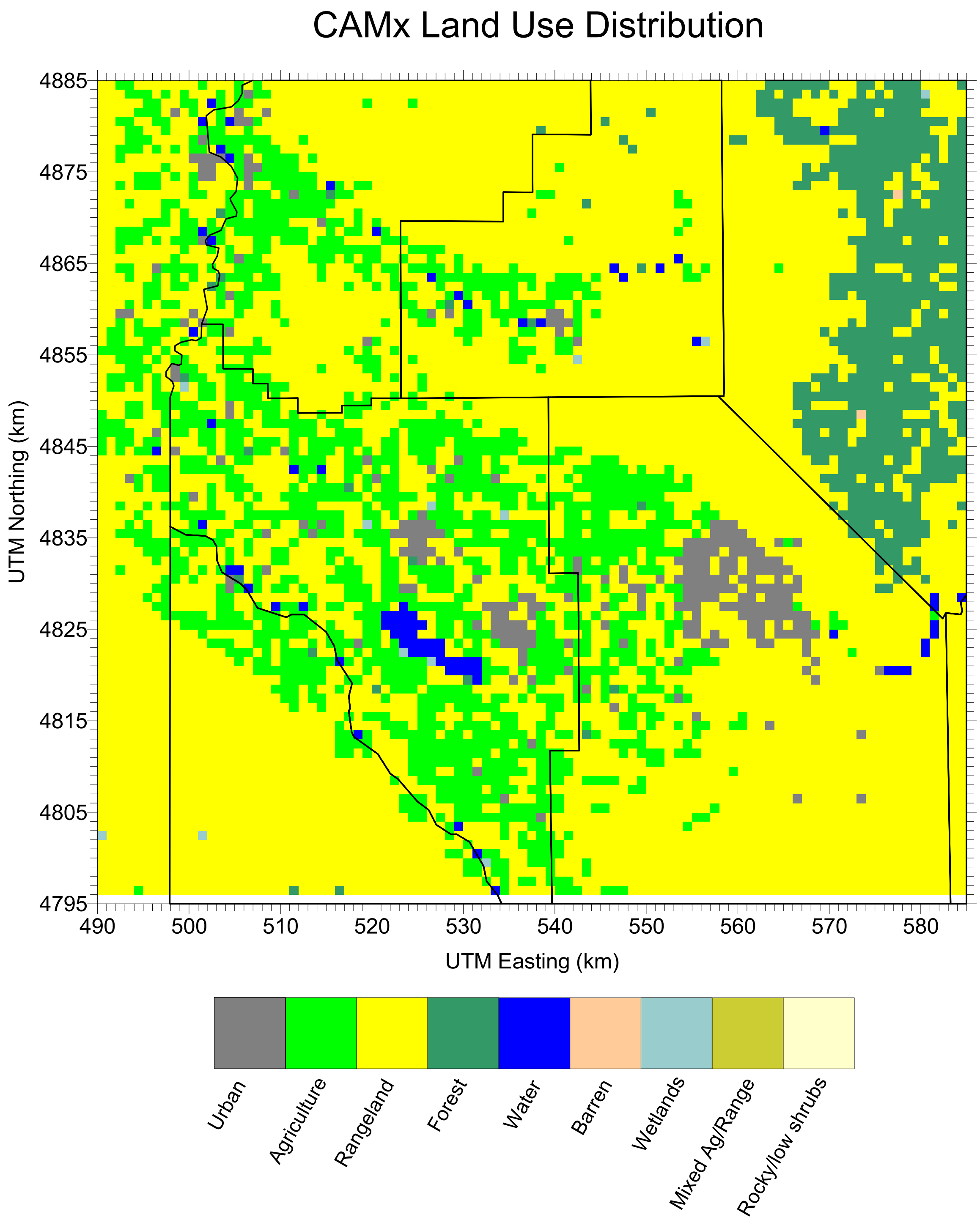


Figure 5-1. CAMx land use distribution used for the Ada County PM modeling application. The dominant classification is shown for each cell, although the fractional coverage of all 11 categories per cell are supplied to CAMx.

Table 5-4. Aerosol size parameters specified in the CAMx Mechanism 4 chemistry parameters file.

Species	Log-mean Diameter (micron)	Density (g/cm^3)
Sulfate	0.32	1.5
Nitrate	0.32	1.5
Ammonium	0.32	1.5
Organics	0.32	1.0
Elemental Carbon	0.32	2.0
Other Primary Fine	1.00	3.0
Primary Coarse	45.00[1]	3.0

[1]The size of coarse PM was set large to increase sedimentation rates, as described in Section 6.

2. *Photolysis Rates*: The photolysis rates file determines the rates for chemical reactions in the mechanism that are driven by sunlight. The file is essentially a very large lookup table for 6 primary photolysis reactions (for mechanism 4), with dimensions over zenith angle, altitude, UV surface albedo, haze turbidity, and total integrated ozone column. The photolysis rates file was prepared using version 4 of the TUV radiative transfer model (provided with the CAMx system).

3. *Albedo/Haze/Ozone File*: The photolysis rates depend upon the surface UV albedo, atmospheric haze and the stratospheric ozone column. The albedo/haze/ozone file specifies how these parameters vary in time and space for the CAMx simulation. The photolysis rates and albedo/haze/ozone files must be coordinated to function together correctly. The time-invariant surface albedo was determined from the gridded land use data; each land use category is assigned a representative albedo value, and the net value in each cell is calculated according to the relative coverage of each land use category. The stratospheric ozone column data was specified from available satellite data (see Appendix A). Due to a lack of turbidity measurements, a time- and space-constant typical haze turbidity (vertically integrated optical depth) of 0.1 was specified. This turbidity value represents the low end of the range typically measured in polluted urban environments (typcially 0.1 to 0.5); in any event, photolysis rate calculations are not particularly sensitive to the choice of turbidity in this range. The albedo/haze/ozone file was generated using the AHOMAP preprocessing program.

5.3 CAMx OPTIONS

CAMx provides a few user options at runtime to invoke various components of the model. For the Ada County applications, the following options were selected for all base and future year scenarios:

- CAMx Version 3.10 was used in all applications reported here;
- The model was operated in the Mountain Standard time zone;

- The piecewise parabolic method for horizontal advection was selected, as we believe it is numerically superior to the other methods available in CAMx;
- The standard CMC fast chemistry solver was selected for CAMx Chemical Mechanism 4 (the reduced-form PM model with full CB4 gas-phase chemistry);
- Gaseous and aerosol dry deposition was invoked;
- The effects of clouds on photochemistry were included.

It should be noted that the Plume-in-Grid (PiG) submodel was not invoked for these applications. The PiG is a Lagrangian sub-model that is available in CAMx to more properly treat ozone chemistry within large NOx-rich effluent plumes. As such, it is appropriate for large-scale ozone applications using coarse grid resolution of 4 km or larger. In this study, the focus is on PM, which PiG does not treat, and the grid resolution is especially high (1 km).

Wet deposition was also not invoked. The CAMx algorithm determines wet scavenging rates for grid cells in which liquid precipitation rates meet or exceed 0.01 in/hr (this is the reporting limit adopted by the National Weather Service). In both episodes, some light, mainly frozen precipitation did fall occasionally in various areas of the domain, and MM5 simulated this to some extent (see the Meteorological Modeling report). However, simulated and observed precipitation never exceeded the liquid 0.01 in/hr threshold in the domain, and so wet deposition calculations would have been bypassed in the model anyway.

The CAMx "probing tools" were not used in the modeling applications. These tools include process analysis (PA), the decoupled direct method of sensitivity coefficients (DDM), and the ozone source apportionment technology (OSAT). While quite useful in evaluating model performance, sensitivity, uncertainty, and source attribution, all of these probing tools are currently only operational for ozone modeling.

6.0 EPISODIC MODEL PERFORMANCE EVALUATION

A rigorous model performance evaluation was undertaken as part of the CAMx Base Case application. The purpose of the evaluation was to build confidence in the model's reliability as a PM prediction tool. Detailed analyses were performed for the December 1999 PM episode to ensure that the model accurately predicts the timing, location, and chemical speciation of PM throughout the area of interest. Specific attention was given to the secondary PM products. The performance evaluation provided insight into the following:

- Are PM patterns simulated well according to observations?
- Are PM patterns simulated well according to the conceptual model of PM buildup in the Treasure Valley?
- What are the reasons for poor performance?
- Are good results robust (are they the result of a proper distribution among species, proper transport/buildup mechanisms, etc.), or are they serendipitous?
- What is the sensitivity of the model to modifications in key inputs with the largest uncertainty (vertical diffusion, emissions, aerosol size, etc.)?

6.1 APPROACH

The evaluation approach described herein is a summary of that provided in the Modeling Protocol document for this project. The EPA has provided guidance on PM_0 modeling (EPA, 1987), and has recently released draft guidance for fine PM and regional haze modeling (EPA, 2001). The older guidance addresses receptor and inert plume-oriented dispersion modeling, and includes steps to reconcile the results from the two approaches. The new draft guidance recognizes the shift toward Eulerian dispersion models to properly treat the details of fine PM formation, transport, and fate. Hence, the latest guidance from EPA is more applicable to this study, and so the approach described below is oriented more toward it.

6.1.1 Draft EPA Guidance on Fine Particulate Modeling

EPA (2001) classifies the evaluation into two categories ("operational" and "diagnostic"), following recommendations developed by Seigneur et al. (2000). Operational evaluations include graphics, PM component metrics, comparisons with observational models (e.g., CMB), and statistical analyses. Diagnostic assessments can be made in several ways, including sensitivity tests to various input parameters with the largest known uncertainty (diffusivity, emissions components), and the evaluation of precursor species as an independent check on source strengths, transport and chemistry. The performance evaluation undertaken in this study included these approaches to the extent that they were supported by measurement data in the Treasure Valley. The specific analyses undertaken are described elsewhere in this Section.

It is first important to establish a framework for assessing whether the modeling system performs with sufficient reliability to justify its use in developing implementation plans. The framework for assessing the model's reliability consists of the following principles, which are based on EPA's draft modeling guidance (EPA, 2001):

- *The Model Should be Viewed as a System*. When we refer to evaluating a "model" we include not only the CAMx photochemical model, but its various companion preprocessor models, the supporting aerometric and emissions database, and all other related analytical and numerical procedures used to produce modeling results.

- *Model Acceptance is a Continuing Process of Non-Rejection*. Over-reliance on explicit or implied model "acceptance" criteria should be avoided. Models should be accepted gradually as a consequence of successive non-rejections, and confidence builds as the model undergoes a number of different applications (usually involving stressful performance testing) without encountering major or fatal flaws that cause the model to be rejected.

- *Criteria for Judging Model Performance Must Remain Flexible*. This approach recognizes the several new elements introduced to the Treasure Valley application including the use of (a) the latest local emissions data sets, and (b) the first use of a comprehensive Eulerian modeling tool.

- *Previous Experience is Used as a Guide for Judging Model Acceptability*. Interpretation of the CAMx modeling results for the episode, against the backdrop of previous modeling experience, aids in identifying potential performance problems and suggests whether the model should be tested further or rejected.

The operational analyses of model performance include quantitative statistical measures that directly compare model predictions with measurement data. The EPA guidance provides suggestions on quantitative performance goals for two standard metrics: aggregated bias (signed error) and aggregated gross (unsigned) error. However, the guidance admits that it is difficult to establish generally applicable numerical goals for these metrics due to the physio-chemical complexities of the PM constituents.

The guidance states, "if the current observed concentration of a component is small relative to observed concentrations of other components, it is not particularly important how closely the model replicates its observations – since the observed concentration is small, a poor prediction can have little effect on the outcome of the modeled attainment test." Furthermore, poor performance may have its greatest effect on the future year demonstration if the model under predicts concentrations of a component. Therefore, the guidance suggests that "…States should be most concerned over model performance if there are discrepancies (especially under predictions) between observations and predictions for components constituting a major portion of the observed mass of $PM_{2.5}$…" Another important goal when considering model performance is to be able to predict not only the absolute concentrations of PM components (sulfate, nitrate, organics, etc.), but also their relative proportions that approximate the observed PM mass budget.

The January 2001 draft of the EPA guidance states that there was little basis for making recommendations for statistical performance goals at the time, but it does summarize results from a few modeling data sets described by Seigneur (2000). This may change with updates to the guidance. The statistical PM performance summaries are given in Table 6-1, along with the performance goals historically established for ozone modeling. Generally, the numbers presented for PM performance are not as good as typically expected for ozone models, so "poorer performance for PM models should not be surprising" (EPA, 2001). This is because of the additional physio-chemical processes affecting the formation and fate of PM over that for ozone. "Thus, States should regard previously identified performance goals for ozone models as upper bounds (i.e., more stringent) for what one might expect for models of particulate matter and its components."

Table 6-1. Limited observed performance statistics for particulate matter models, from draft EPA modeling guidance (EPA, 2001). Also shown are established performance goals for ozone modeling.

Pollutant	Gross Error[1]	Bias
$PM_{2.5}$	30-50%	+10%[2]
Sulfate	30-50%	-20 to –30%[3]
Nitrate	20-70%	-15 to +50%[3]
EC	15-60%	N/A
OC	40-50%	+38%[2]
Ozone	<35%	< ±15%

[1] Based on 3 sets of model-observation comparisons (different models/locations)
[2] Based on 1 set of model-observation comparisons
[3] Based on 2 sets of model-observation comparisons (different model/locations)

Sufficient fulfillment of EPA's suggested evaluation requires the availability of comprehensive measurement data on PM and precursors from an extensive monitoring network. The guidance realizes that this may not be feasible in all cases, particularly in regards to precursor measurements. It is also quite possible that the approach will change with the release of final guidance by EPA. Indeed, while the December 20-26, 1999 period provided a much better measurement database than available during the January 1991 exceedance episode, it did lack precursor concentration measurements, and only provided speciated PM data at two sites in the domain (see discussion of measurement database below, and in Appendix A). Therefore, several of the EPA-recommended performance evaluation steps could not be undertaken in this study.

6.1.2 Evaluation of CAMx Performance for the Treasure Valley

Incorporating the principles discussed above into an operational philosophy for judging model performance, the Modeling Protocol suggested the following approach for assessing the reliability of the CAMx for the Ada County PM_{10} maintenance plan. The model should produce performance statistics within the approximate ranges as recommended by EPA (2001). If the model's performance is better than all of these ranges, the base case would not be rejected unless evidence from any supplemental diagnostic or sensitivity simulations suggest unusual or aberrant behavior.

If the base case fails any one of the above general ranges, it would become necessary to explain why the performance is poorer than commonly achieved in similar applications and whether the problems will compromise the evaluation of emission control strategies. Otherwise, the particular base case in question, or a portion thereof, should be declared inadequate. This outcome would result in one of several courses of action: (a) diagnose the causes of poor performance and rectify such problems, or (b) eliminate the poor-performing episode or particular days from use in strategy development and/or identify an alternative episode for substitution in the study.

Initial screening of the CAMx base case predictions were performed for the December 1999 modeling episode in an attempt to identify an obviously flawed model simulation and to implement improvements to the model input files in a logical, defensible manner. Experience in PM modeling is the best basis upon which to identify obviously flawed simulation results. Efforts to improve model performance, where necessary and warranted (i.e., to reduce the discrepancies between model estimates and observations), was based on sound scientific principles.

Once the screening phase suggested that no obvious flaws or compensating errors existed in the simulation, we progressed to the operational evaluation. A limited number of diagnostic simulations were performed to help understand and possibly improve base case model performance. In addition, sensitivity tests were performed to diagnose model sensitivity to changes in key inputs. These tests are an important component of thebase case model evaluation process. In general, diagnostic and sensitivity analyses serve to:

- Reveal model responses that are inconsistent with expectations or other model responses.
- Identify what parameters (or inputs) dominate (or do not dominate) model results.
- Examine the relationship between uncertainties in model inputs and model outputs (error propagation through the model).
- Identify alternate base cases that offer similar model performance and therefore identify potential compensating errors.
- Provide guidance for model refinement and data collection programs.

With the advent of more sophisticated models (such as CAMx), a number of sensitivity runs that were historically carried out with the UAM model are no longer needed or appropriate. These tests are zero-emission, zero initial condition, zero boundary condition runs and arbitrarily and/or locally modified wind field tests such as halving the wind speeds. Physically unrealistic tests such as these can produce misleading results that are difficult to interpret. For the zero emission and zero IC/BC sensitivity tests, more can be learned from looking at sensitivity to alternate (but physically possible) inputs. Ad-hoc modifications to windfields external to meteorological models are not recommended because they destroy consistency among the meteorological inputs (e.g., winds that are physically unrelated to pressures and temperatures). Other types of meteorological experiments are potentially more useful, such as alternate vertical eddy diffusivities or alternate runs of the meteorological model. The results from these are described in the next sections.

6.1.3 Air Quality Data

Table 6-2 lists the various aerosol monitoring sites in operation during the December 1999 modeling episode. The table also summarizes the types of data recorded and analyzed. The locations of these sites are superimposed onto the modeling domain in Figure 6-1. Data from all of these sources were used in the evaluation of CAMx performance described in Sections 6.2 and 6.3 below. See also Appendix A.

Table 6-2. Monitoring sites from the DRI 1999/2000 Treasure Valley fine PM monitoring network, and data sampling schedules specific to the December 1999 episode.

Site Name/ Abbreviation	UTM (km)	Measurements
BFS5 – Boise Fire Station #5	563.452 E 4829.630 N	4/5-hr speciated fine mass: 12/22-25 4/5-hr $PM_{2.5}$: 12/21-25 24-hr speciated PM_{10}: 12/22,24,25 24-hr PM_{10}: 12/20-26
BCLO – Cloverdale	556.431 E 4805.671 N	4/5-hr speciated fine mass: 12/22-25 4/5-hr $PM_{2.5}$: 12/21-25
BMVS – Mountain View School	558.863 E 4831.501 N	24-hr $PM_{2.5}$: 12/21-26 24-hr PM_{10}: 12/20,26
MFS1 – Meridian Fire Station	549.019 E 4829.354 N	24-hr PM_{10}: 12/20,26
NFS1 – Nampa Fire Station	535.309 E 4825.136 N	24-hr PM_{10}: 12/20,26
BWPS – Boise White Pine School	566.355 E 4825.070 N	24-hr $PM_{2.5}$: 12/20,23,26
CSMS – Caldwell Syringa School	525.385 E 4832.345 N	24-hr $PM_{2.5}$: 12/20,23,26

6.2 DEVELOPMENT OF THE DECEMBER 20-26, 1999 SIMULATION

The development of the December 1999 model simulation was carried out in a series of fifteen individual runs. All of these runs utilized meteorological input fields derived from MM5 "Run 3" (see the supplementary Meteorological Modeling report). In each case, a deficiency in the air quality model or its inputs was identified, a plan to rectify the problem was developed, and another run to verify the impact on simulated PM was undertaken. Qualitative descriptions of the various modifications and improvements that were made during this process, and a quick summary of their impacts relative to measurements at the Boise Fire Station #5 (BFS5), are listed below. A discussion summarizing the quantitative performance evaluation of the final run, along with results from diagnostic tests, are provided in Section 6.3.

- A series of four initial screening runs were made to diagnose errors in model inputs and problems in the model itself. This is a standard approach required in every modeling study to ensure that the model and its inputs are operating correctly. The following modifications were made from analyses of these runs:

1) The dry deposition routine was altered to allow the user to specify the particle size and density for each individual modeled species, as described in Section 5 (Table 5-4). Up to this point, Mechanism 4 had treated all species identically (size range of 0.1-10 microns, density of 1.5 g/cm^3).
2) The single primary PM_{10} species originally carried by Mechanism 4 was split into organic carbon (OC), elemental carbon (EC), remaining fine mass (PFIN), and coarse mass (PCRS). PM_{10} emissions from road dust were assumed to be entirely in the coarse mode, based on Tracker measurements provided by DRI (Entyemezian et al., 2002). At this point, PM_{10} emissions from all other source categories were assumed to emit only in the fine mode, and these were split among OC, EC, and PFIN according to the $PM_{2.5}$ speciation profile library taken from the REMSAD emissions processing system.
3) A diurnal activity profile was applied to the road dust, which had originally been processed as a constant emissions rate over the day. The same hourly vehicle activity profile that was used to distribute all other on-road mobile source emissions was also used for coarse road dust.

Results: Rather good performance was seen for secondary species (sulfate, nitrate, and ammonium) over the modeling episode. Organic and elemental carbon species tended to be under predicted by ~50% early in the episode, were well predicted on December 24 (the day of highest measured 24-hour PM_{10}), and quite over predicted by ~100% on the last two days of the simulation. As discussed further below, the cause of this widely varying performance for the carbons over the episode was mainly due to the wood smoke emission estimates. Remaining fine mass (PFIN) was over predicted by a factor of 2-4 over the episode. Similarly, coarse mass (PCRS) was generally over predicted by a factor of 8 from December 20-24, and by an extreme margin on the last two days (400+ $\mu g/m^3$ predicted vs. 2 $\mu g/m^3$ observed). The reasons for the very poor performance in PFIN and PCRS were investigated next.

- Road dust inventories were reprocessed to account for month-of-year and day-of-week variations, which up to this point had been ignored. Also, the road dust inventory was scaled down by a factor of 4 to test the approach used in many other studies to reduce road dust over predictions.

  Results: Predictions of PCRS at BFS5 varied from 60-90 $\mu g/m^3$ over the episode, which remained a factor of 2-3 times too high on the key high PM days.

- CAMx was modified to use a longer time step without destabilizing the numerical solutions in the model. Minimum time steps were increased from 18 seconds to about 30 seconds. Also, a new capability was added to CAMx to utilize OpenMP parallelization directives to take advantage of multi-processor PC's. From this point forward, CAMx was run on dual-processor machines to increase model execution speed.

  Results: No changes in species concentrations were seen, while the model was effectively sped up by about a factor of ~2.5.

- The 1999 base year emissions inventory was reprocessed through EPS2 to include the following changes:
  1) Recognizing that PM emissions from most source categories are not entirely $PM_{2.5}$, as assumed up to this point, the PM_{10} emissions for all source categories except road dust were first split into coarse and fine modes based on category-specific factors developed from the national REMSAD emissions processing system. Road dust was still considered to be completely in the coarse mode. Then the fine mode emissions from each source category were further split into EC, OC and PFIN using the REMSAD $PM_{2.5}$ factors as described above.
  2) Road dust emission rates were set back to the full DRI Tracker rates (i.e., not divided by 4).

  Results: Performance for secondary species remained unchanged and quite good. The performance for the carbon species improved overall, but over predictions remained late in the period (by a factor of 4-5 on December 25). PFIN remained over predicted by a factor of 2-4 over the episode. With full road dust emission rates, PCRS was a factor of about 10 times too high on the key high PM days.

- A large increase in coarse mode sedimentation rates was applied by dramatically increasing the representative aerosol size for PCRS. Deposition rates were increased by a factor of about 10 to account for near-source removal and to reduce the over estimate of instantaneous transport of primary coarse emissions (Table 5-4 shows the final PCRS size). Appendix B provides a memorandum from the IDEQ that discusses the technical issues surrounding coarse particle over predictions in Eulerian dispersion models. This is summarized in Section 6.2.1 below.

  Results: Performance for PCRS improved to near zero bias/error with the increased deposition rates. With the remaining over predictions in PFIN, the error in total PM_0 was reduced from over 400% to about 50% during the key high PM days.

- The following EPS2 processing modifications were made to residential wood combustion (RWC), which include categories for fireplaces, woodstoves, and open burning:
  1) The hourly diurnal allocation for RWC PM_{10} was changed from the standard EPS2 profile for these source categories to the "woodsmoke" profile used by IDEQ in past modeling. The respective profiles are shown in Figure 6-2, and shows a large decrease in activity during morning and late evening hours.
  2) The RWC $PM_{2.5}$ speciation splits from REMSAD were replaced with profiles developed from the receptor modeling component of this study (Cooper and Johnson, 2002). This resulted in shifting more emissions into OC and EC, and less into PFIN (Table 6-3).
  3) Weekday and weekend RWC emission rates were scaled to reflect the results from the latest IDEQ wood burning survey taken in 2001 (Tarnai and Allen, 2001). In Ada County, the scaling factors were 0.9747 and 0.5199 for weekdays and weekends, respectively. In Canyon County, the factors were 1.2162 and 0.6486, respectively.
  4) Open burning was removed from the episodic modeling inventory for the 1999 base year and for all future years, according to information from IDEQ that this category is not active in winter months (McGown, personal communication).

Results: Acceptable model performance was established for primary and secondary PM on December 20-24, while PM_{10} remained quite over predicted on December 25-26. Results from the final run are described in more detail in Section 6.3.

Table 6-3. Speciation split factors for wood smoke based upon the profile used by Cooper (2002), and profiles obtained from the REMSAD emissions processing system.

Species	CMB Splits (% $PM_{2.5}$)	REMSAD Splits (% $PM_{2.5}$)
OC	76	56
EC	19	11
PFIN	5	33

6.2.1 The Issue of Road Dust Over Predictions

Eulerian grid models are formulated to discretize real-world continuous fields into a simulated-world of spatial and temporal “pixels”. The spatial pixels are referred to as grid cells with a certain horizontal “resolution” and vertical depth, while the temporal pixels are referred to as time steps. Furthermore, the physio-chemical processes that act on the resolved concentrations (transport, diffusion, removal, chemical production/decay) are “split”, meaning that each operates separately and individually in a sequence. In reality, these processes act simultaneously. The approximation and numerical errors associated with this discretization process are reduced as the space and time resolution increases toward the limit of a continuous treatment. Obviously, model resolution is controlled by practical, theoretical, and computational limitations, and so tradeoffs must be established to balance the model’s capabilities and precision with an acceptable level of performance.

Eulerian air quality models work best when the time scales of emissions dilution into grid cells, and pollutant dispersion from cell to cell, are much shorter than the time scales of pollutant perturbations caused by chemical change or removal by deposition to the surface. In other words, these models best characterize conditions when the chemical and removal processes are relatively minor time step to time step and cell to cell. This is the case for the vast majority of pollutant species with which we are concerned. Unfortunately, the physio-chemical characteristics of a few species lead to very fast decay or production rates, thereby violating the inherent assumption that these species can be instantaneously diluted across an entire grid cell volume over a single time step before experiencing a significant chemical or sedimentary perturbation.

It is well known by model users that Eulerian grid dispersion models generally over estimate coarse road dust concentrations. Compared to monitoring data and receptor modeling analyses, grid modeling often over estimates the road dust by a factor of four or more. Investigations indicate that the over prediction is due to systematic errors rather than random errors. It is unlikely caused by errors in emission factors, VMT data, or the resolved dispersion mechanics, however, treatment of deposition processes may be the problem. In other words, the decay of coarse road dust particulate mass by deposition operates on a time scale that is much shorter than the characteristic dispersion time scale, thereby violating the inherent assumptions of grid models.

All grid dispersion models instantaneously distribute particulate emissions uniformly through the depth of the lowest modeling layer, which is usually 20 meters or higher. However, measurements indicate that the road dust only reaches an elevation of a few meters above the ground. The particles are not uniformly distributed in this shallow layer, but concentrated in lower part of the layer. The coarse particles are removed near the source by gravitational force and impaction onto vegetation and structures in a relatively short time. Because the coarse particles are removed in a much shorter time than grid models inherently resolve, the actual mass deposition at each time step is significant and cannot be accounted for by the models. These issues are critical for the modeling predictions.

The analysis undertaken by IDEQ (see Appendix B) indicates that grid models could over-estimate road dust concentrations by a factor ranging from 2.5 to 11 due to the treatments of instantaneous dilution of emissions through deep layers, time splitting operations, and unresolved deposition processes, all of which affect removal rates. These are all systematic errors in the modeling. It was for these reasons that we implemented the increase in deposition rates for PCRS by increasing the effective size of the aerosol in the CAMx Mechanism 4 chemistry parameters file (Table 5-4).

6.3 MODEL PERFORMANCE FOR DECEMBER 20-26, 1999

This section provides a discussion on CAMx model performance in replicating measured speciated and total PM_{10} in the Treasure Valley during the December 20-26, 1999 episode. The presentation begins with a review of performance for "Run 15", the final model application of the developmental runs described above. We then provide some comparative analyses of two additional runs in which alternative meteorological fields were input to the model to test sensitivity and to gauge model uncertainty to various meteorological realizations.

6.3.1 Evaluation of Run 15

6.3.1.1 Total and Speciated 24-Hour PM_{10}

Figure 6-3 presents the observed and predicted 24-hour PM_{10} at four monitoring sites operating during the DRI field study, including Boise Fire Station #5 (BFS5), Mountain View School (BMVS), Meridian Fire Station (MFS1), and Nampa Fire Station (NFS1). PM_{10} measurements were available each day of the episode at BFS5, but were only taken on December 20 and 26 at the other three sites. Overall, CAMx performed quite well in replicating the measurements on all days and at all sites over December 20-24, especially on the three highest days, but failed to reproduce the sudden decrease in PM at the Boise sites on December 25 and 26. The model performed better at the Meridian andNampa sites on December 26. The bias (relative error) on each day is shown in Table 6-4, along with the average over December 20-24 at BFS5.

Table 6-4. Comparison of observed and predicted 24-hour PM_{10} from CAMx Run 15.

Date	Observed (μg/m³)	Predicted (μg/m³)	Error (%)
BFS5			
Dec 20	51	82	61
Dec 21	69	72	4
Dec 22	70	73	4
Dec 23	57	87	52
Dec 24	69	76	10
Dec 20-24 Avg			26
Dec 25	37	94	153
Dec 26	23	89	287
BMVS			
Dec 20	29	46	57
Dec 26	21	72	242
MFS1			
Dec 20	23	36	55
Dec 26	25	43	70
NFS1			
Dec 20	28	41	47
Dec 26	42	50	19

Figure 6-4 shows similar plots of observation-prediction comparisons for particle sulfate (PSO4), nitrate (PNO3), ammonium (PNH4), organic carbon (OC), elemental carbon (EC), other primary fine mass (PFIN), and primary coarse mass (PCRS). BFS5 was the only site with 24-hour speciated PM_{10} samples. Table 6-5 provides the error statistics for these species.

Sulfate appears to be well replicated early in the period, but the model missed the spikes on December 24 and 25. The model maintained a flat concentration trend at BFS5 throughout the episode at a bit over 1 $\mu g/m^3$. Predicted sulfate at the Nampa and Meridian sites did spike up to 5.0 and 2.5 $\mu g/m^3$ on December 25, respectively (not shown as no sulfate measurements were available). The conceptual model for local sulfate formation in the Treasure Valley is based upon the presence of fog. A heavy ice fog did form late on December 24 and persisted for the duration of the episode and throughout the valley. This is likely to be the cause for the higher observed sulfate on these days. While CAMx did not replicate this effect at BFS5, it did produce it in other areas of the valley, indicating that the reduced form aqueous chemistry is able to appropriately generate elevated sulfate concentrations in such conditions. The cause for the sulfate miss in Boise is probably related to the meteorological simulation: (1) the simulated winds might have transported specific sulfate plumes toward the south of Boise; and (2) the MM5 did not generate much fog in Ada County area during the last three days (see the supplementary Meteorological Modeling report).

The measured and simulated trends in particulate nitrate were similar to sulfate, although the nitrate concentrations were higher. CAMx simulated a weakly increasing concentration trend over the episode at BFS5 (6-8 $\mu g/m^3$) while again the measurements increased from $\sim 3\,\mu g/m^3$

Table 6-5. Comparison of observed and predicted 24-hour speciated PM from CAMx Run 15. Speciated measurements were available for December 22, 24, and 25 at BFS5 only.

Date	Observed ($\mu g/m^3$)	Predicted ($\mu g/m^3$)	Error (%)
Sulfate			
Dec 22	1.07	1.20	12
Dec 24	4.08	1.07	-74
Dec 25	2.60	1.47	-43
Nitrate			
Dec 22	3.40	6.69	97
Dec 24	12.17	7.25	-40
Dec 25	11.78	8.39	-29
Ammonium			
Dec 22	0.70	2.37	239
Dec 24	3.87	2.49	-36
Dec 25	3.61	2.97	-18
Organic C			
Dec 22	17.75	13.52	-24
Dec 24	17.21	26.74	55
Dec 25	9.72	35.63	267
Elemental C			
Dec 22	5.82	4.78	-18
Dec 24	4.65	7.69	65
Dec 25	2.75	10.06	266
Other Fine			
Dec 22	4.27	2.74	-36
Dec 24	4.67	2.89	-38
Dec 25	4.83	3.49	-28
Coarse			
Dec 22	36.99	41.27	12
Dec 24	22.35	27.57	23
Dec 25	1.71	31.74	1756

to $\sim 12\ \mu g/m^3$ on December 24 and 25. The simulated nitrate trend at BFS5 was mirrored at the other sites, so it is difficult to understand the cause of the observed nitrate spike at BFS5. One possible explanation may be a heterogeneous nitrate formation pathway, similar to sulfate, on the surfaces of the ice crystals comprising the fog. No air quality model, full-science or otherwise, currently addresses this effect.

Ammonium concentrations are associated with both sulfate and nitrate. As such, we would expect to see performance for ammonium track with sulfate and nitrate trends. Figure 6-4 shows that this was certainly the case. Predictions show a weakly increasing trend over the episode, while the observations spiked from below $1\ \mu g/m^3$ to nearly $4\ \mu g/m^3$ on December 24. However, in this case ammonium was generally over predicted in the early portion of the episode by a factor of about 3. This resulted in fairly mild under predictions on the high days of December 24 and 25.

Moving to primary particulate species, the organic carbon simulation was quite good for most of the episode until December 25, when concentrations were over predicted by over a factor of 3. In fact, the same performance characteristics are seen with elemental carbon as well. This makes sense, as these two carbon species (both measured and observed) are dominated by residential wood combustion in this region. It is possible that the low observed carbon concentrations on December 25 were caused by a reduction in actual wood smoke emissions and increased deposition rates in the fog. The model did not account for these.

The remaining primary fine mass was well replicated over the entire episode, with concentrations ranging from 2-4 $\mu g/m^3$. Predictions at all four sites were of similar magnitude and of moderately flat trend; in Nampa, the trend was slightly more exaggerated with a peak on December 25 of nearly 8 $\mu g/m^3$. Again, no speciated observational data were available there to confirm this feature. The primary coarse mass was also well replicated through December 24, and follows the generally decreasing trend during the period. However, CAMx did not simulate the sudden decrease of PCRS on December 25 ($<2 \mu g/m^3$ observed vs. 32 $\mu g/m^3$ predicted). The cause of this is probably related to a significant reduction in actual road dust emissions on December 25 due to wetted road surface in the presence of the fog, and to increased removal by the fog.

In summary, the performance for secondary species was quite good over December 20-23, but concentrations were under predicted on December 24-25. Performance for primary species was good from December 20-24, but the carbons and coarse mass were over predicted on December 25 (and likely on the 26th as well). The cause for the under predicted secondary species late in the period appears to be related to a lack of heterogeneous formation in the fog that formed during this period, which relates to deficiencies in the meteorological simulation. The cause for the over predicted primary species late in the period appears to be related to an over abundance of emissions (especially coarse road dust), and to a lack of removal by the fog.

6.3.1.2 High-Frequency Speciated PM2.5

As part of the DRI fine particulate study, high-frequency $PM_{2.5}$ filter samples were analyzed for the December 21-25 period at two sites, Boise Fire Station #5 and a site well to the south called Cloverdale (BCLO). The latter site was used to characterize conditions well outside of Boise to help define rural-level background conditions. At both sites, fine PM was sampled during four periods of each day: 00:00-05:00, 05:00-10:00, 10:00-14:00, 14:00-19:00, and 19:00-24:00. However, on December 25, only three samples were taken at 00:00-10:00, 10:00-19:00, and 19:00-24:00. This section compares the speciated filter data with CAMx predictions at both sites. Hourly output from CAMx was processed to the various 4- and 5-hour sampling periods.

Figure 6-5 shows a comparison of the $PM_{2.5}$ measurements and predictions (the sum of all aerosol species from CAMx except PCRS) at BFS5 and BCLO. The model performance at

BFS5 was quite good through December 24, but was consistently high on December 25 as seen in the previous results. The intra-diurnal patterns seem to match up well. However, there was an obvious spike each day during the 19:00-24:00 period. At BCLO, the performance was acceptable during the first day or so, but CAMx under predicted significantly over December 23-25. This indicates that CAMx did not transport a sufficient quantity of aerosol southward into this area, as the predictions were nearly constant at the boundary condition levels. This points to performance issues with the wind fields, which appear to be carrying clean boundary conditions northward to the BCLO site as opposed to carrying urban air southward. Based on the observations at this site, it would appear that the site was not established sufficiently distant from Boise to measure background levels (e.g., note the identical 40+ $\mu g/m^3$ readings at BFS5 and BCLO for the 14:00-19:00 period on December 24).

Figure 6-6 provides similar plots for the various aerosol species. A summary of statistical performance is given in Table 6-6. Sulfate was well replicated at BFS5 from December 21 through 23. The model performed admirably in simulating the rapid sulfate rise late on the 23rd, but failed to maintain relatively high sulfate levels afterwards. Measured sulfate levels peaked at over 5 $\mu g/m^3$ on the afternoon of the 24th. It is quite possible that the modeled sulfate plume missed this particular monitor. At BCLO, sulfate was under predicted by a large margin during the late period, again showing that the simulation was dominated by the very low boundary condition values. The observations indicate a sulfate plume measurement during the afternoon of the 24th, which is higher than that measured at BFS5.

Performance for predicted nitrate at BFS5 was more variable day-to-day. The simulation showed a very regular pattern each day, peaking in the early morning, and decreasing to the afternoon, which follows the temperature and humidity pattern. The observations did not show any obvious diurnal trends, just an eventual buildup of nitrate each day until the peak on the afternoon of December 24. Predicted nitrate at BCLO was rather steady at background levels. Again, the nearly identical measurement trend at BFS5 and BCLO suggests that the urban plume flowed well southward. The performance for ammonium was quite similar to nitrate, since more ammonium is associated with nitrate relative to sulfate.

Organic carbon at BFS5 was well simulated until December 25, when it was highly over predicted. Here we see the spikes each day during the 19:00-24:00 period, which is the cause for the daily spikes in predicted $PM_{2.5}$. We attribute this to the heavy burden of modeled wood smoke emissions during this period. In the developmental runs, these spikes were nearly twice as high when the default EPS2 activity profile was used. Much better performance was seen when the IDEQ wood smoke activity profile was applied. Concentrations were dramatically under predicted at BCLO, where the measurements were less than half the BFS5 values. This suggests that much of the organics at BFS5 are attributed to local sources. Identical features were seen for predictions and observations of elemental carbon, further suggesting the dominance of wood smoke in the actual and modeling inventories.

Table 6-6. Performance statistics at BFS5 for total and speciated PM2.5, from thehigh-frequency sampling data shown in Figures 6-5 and 6-6.

Date Range	Bias (%)	Gross Error (%)
$PM_{2.5}$		
Dec 21-24	23	43
Dec 21-25	32	50
Sulfate		
Dec 22-24	17	64
Dec 22-25	8	61
Nitrate		
Dec 22-24	44	89
Dec 22-25	33	78
Ammonium		
Dec 22-24	74	107
Dec 22-25	58	93
Organic C		
Dec 22-24	44	69
Dec 22-25	84	105
Elemental C		
Dec 22-24	51	74
Dec 22-25	94	113
Other Fine		
Dec 22-24	-15	42
Dec 22-25	-14	45

Performance for remaining fine mass at BFS5 varied from sample to sample, but overall the trend was for a slight under prediction. The same modeled spikes occurred during the 19:00-24:00 segment, which again suggests wood combustion as the source even with the much lower contribution when speciation was revised to reflect receptor modeling. The shear quantity of modeled wood smoke emissions injected during those hours dominates even a minor species such as this. Performance at BCLO was better than seen for any other species, mainly because this site measured this component at relatively low background levels. Still, the model missed some obvious urban plume spikes on the last two days of the episode.

The gross errors for most species over December 21-24 (Table 6-6) are just outside the range reported in draft EPA guidance (Table 6-1). Including December 25 increases gross error for 3 of the 5 individual species shown, and slightly increases it for $PM_{2.5}$. However, there remains no formal acceptance "limits" from EPA guidance. Further, EPA states that it is best to over predict major components, rather than under predict them.

In summary, performance replicating the high-frequency $PM_{2.5}$ filter data was quite good through December 24, but then was over predicted on December 25 and 26. The good performance for total fine mass for the majority of the episode was a result of a balance between generally under predicted secondary species and over predicted primary species. But the performance for each chemical constituent was not outside what has been modeled in other studies, as indicated by the Draft EPA guidance for fine PM modeling (EPA, 2001). The over prediction of total fine mass late in the period appears to be due to a dominance of wood smoke, which is only slightly counter balanced by the under predictions in secondary fine mass. The latter might be explained by a lack of heterogeneous formation in the ubiquitous fog, and possibly also transport error for sulfate plumes.

6.3.1.3 Additional 24-Hour PM2.5

Additional sites were established during the DRI fine particulate study to measure 24-hour total fine mass (un-speciated) throughout the Treasure Valley. These included three locations: Mountain View School (BMVS), White Pine School (BWPS), and Syringa School (CSMS). Figure 6-7 presents a comparison between the measurements and the CAMx predicted fine mass. Measurements were only available on December 20, 23, and 26 at White Pine and Syringa schools, while samples were taken each day at Mountain View School.

At BMVS the model performed well in simulating the day-to-day buildup of fine mass in central Boise up through December 24. Whereas the measurements at BMVS show a definite air quality improvement on December 25 and 26, the modeled $PM_{2.5}$ continued to increase to over 60 $\mu g/m^3$. This was caused by a continued upward trend in the modeled primary carbons on these days due to wood smoke (not shown), as similarly seen in the results at BFS5 described previously. At the other two sites, the model over predicted fine mass by over a factor of two on December 20, but performed well on December 23. The model then over predicted by a large margin on December 26 (and likely on the 25th). If the daily measured buildup of PM at BMVS can be extrapolated across the valley, then it would appear that the simulated values at BWPS and CSMS on December 24 faithfully replicated ambient levels at those sites.

6.3.1.4 Conclusions

Figure 6-8 displays the predicted distribution of 24-hour PM_{10} from Run 15 throughout the modeling domain on each day of the December 20-26, 1999 modeling episode. The highest concentrations occur in the urban areas, and on some days the contribution from major transportation routes can be easily distinguished. The blocking effects of terrain to the north, east, and southwest are clearly evident with very low concentrations in those areas. The emissions contributing the major proportion of predicted aerosol mass in the urban areas are wood smoke and road dust. Secondary aerosols provide a lower-level regional background that appear more “wispy” in the plots. Higher secondary concentrations (mainly sulfate) occur along the Snake River channel near Nyssa, Oregon, due to the presence of fog simulated in that area.

While CAMx performance in replicating total PM_{10} and its constituent species appears acceptable over December 20-24, the model is not able to replicate the clearing process on December 25 and 26. It should be noted that the model performs best on the highest PM_{10} days, and that the mass budget (i.e., species contributions to the total) at BFS5 was best represented on December 22-24. This is important as it establishes confidence that the high concentrations are being modeled for the correct reasons. The Idaho Clean Air Force (ICAF) points out that over reliance on speciated data from only a single site in central Boise (BFS5) to evaluate speciated and time-resolved model performance may lead to misleading conclusions. The ICAF suggests that the model may demonstrate good performance at that one site, but that does not guarantee good performance can be transferred to the general domain. The ICAF suggests that the IDEQ broaden the monitoring network to include higher frequency speciated analyses at several locations throughout the Treasure Valley.

Poor performance on the last two low PM_{10} days is related to two major issues:

- Actual emissions peculiar to activities on Christmas Day (Saturday) and the day after (Sunday), especially regarding residential wood burning and traffic volumes, are likely causing a significant deviation from our modeled "typical" weekday/weekend emission estimates;
- The presence of the ice fog that formed late on December 24 probably had some influence on heterogeneous nitrate and sulfate formation (today's models are only able to represent aqueous sulfate formation in liquid fog), certainly increased removal processes for all species (CAMx only estimates wet removal for rainfall rates above 0.01 in/hr), and decreased emissions of road dust due to wet/frozen surfaces. Furthermore, without a dynamic aerosol size model, CAMx could not account for particle growth by hydration in the fog, and their subsequent increase in sedimentation rates.

It is for these reasons that the last two days of the episode are dropped from consideration in the sensitivity analyses described below, and in the analysis of the future year scenarios.

6.3.2 Sensitivity to Alternative Meteorology

Once the base case performance evaluation was completed, and CAMx Run 15 was deemed acceptable for use in diagnostic modeling, two additional simulations were undertaken to test the model's sensitivity to alternative meteorological inputs. The meteorological fields used through CAMx Run 15 were taken from MM5 "Run 3" (see the supplemental Meteorological Modeling report). A new meteorological simulation was carried out with MM5 for the December 1999 episode, called "Run 4", which included some changes in the configuration of various MM5 options. The main purpose of this additional run was to parallel the approach used to develop meteorological fields for the January 1991 episode, which by necessity had to be configured differently than the original MM5 simulation for December 1999 in order to achieve acceptable meteorological model performance for the older episode. The development and performance evaluation of meteorological fields for January 1991 were carried out subsequently and independently once the original MM5 simulations of December 1999 were completed. The concern was that a different means of modeling the meteorology in the January 1991 episode might lead to a significant uncertainty in CAMx relative to the approach used for the December 1999 episode. The tests described in this section attempt to establish some quantitative uncertainty bounds on the PM10 simulation due to the different MM5 modeling approaches.

The supplemental Meteorological Modeling report provides detailed information about the December 1999 (Run 3 and Run 4) and January 1991 (Run 11) simulations. The model configurations in MM5 Run 4 and Run 11 were identical, except of course for the simulation period. Below we list the major differences between MM5 Run 3 and 4 for the December 1999 period that led to major changes in simulation performance:

- MM5 v3.5 was used in Run 4, whereas v3.4 was used in Run 3;
- The Medium Range Forecast (MRF) boundary layer scheme was used in Run 4 instead of the Gayno-Seaman approach in Run 3;
- The Oregon State Land Surface model was used to simulate the surface energy balance in Run 4, instead of the simple 5-layer soil model in Run 3;
- Run 4 instituted data assimilation (nudging) toward gridded three-dimensional analyses on the 1- and 3-km MM5 grids, blended with local wind, temperature, and moisture data as a way to control model drift – no analysis nudging was performed in Run 3 on the two finest grids;
- Run 4 instituted data nudging toward individual temperature observations together with wind and moisture observations – only wind and moisture observational nudging was performed in Run 3.
- Nudging coefficients for assimilation of observed winds and moisture were increased in Run 4 to control model drift.

CAMx was rerun for the December 1999 episode with the same configuration and inputs as Run 15 described in Section 6.3.1, except that the meteorological inputs were taken from MM5 Run 4. This new CAMx simulation was labelled "Run 17". To further check how sensitive CAMx results were to the characterization of vertical diffusivity, yet another simulation (Run 18) used a hyrbid of the new wind, temperature, moisture, and cloud inputs from Run 17 and the original diffusivity inputs in Run 15. An inter-comparison of all three runs are described below.

6.3.2.1 Uncertainty Analysis

Figure 6-9 shows the predictive bias and error (both absolute and relative) by species at the BFS5 site for CAMx runs 15, 17, and 18. The error metrics for total and speciated $PM_{2.5}$ were derived from prediction-observation pairings from the high-frequency filter samples. For individual species, the bias and error were averaged over the December 22-24 samples, and for total $PM_{2.5}$ they were averaged over the December 21-24 samples. The error metrics for total PM_{10} were averaged over the 24-hour samples taken over December 20-24.

The percent bias and gross errors shown in Figure 6-9 are relative to the mean observed 24-hour PM_{10} over December 20-24 (63.2 $\mu g/m^3$ at BFS5). This was done to put the absolute error metrics for each species into a more proper context; more specifically, it characterizes the error of each species in a manner that weights by their relative contribution to the overall PM_{10} mass budget. Thus, large errors associated with species of lesser significance to PM_{10} are presented as a small relative error, as opposed to major components for which any error is more significant to model performance.

In Run 15 the largest error is associated with organics (Figure 6-9), and this contributes to the positive bias and gross error in total $PM_{2.5}$ and ultimately PM_{10} over the episode (PM_{10} error of +15 $\mu g/m^3$ or +23%). Positive bias in the primary coarse mode is also a contributor to PM_{10}

bias. With the introduction of alternative meteorology in Run 17, bias for all fine species decrease (resulting in a negative bias for total $PM_{2.5}$) but the bias for coarse mass increases. However, the fine mass reductions net an overall improvement in the bias for total PM_{10} (bias of -2.5 μg/m^3 or –4%). The gross errors for fine mass species are similar to Run 15, but error for coarse mass has increased significantly. In Run 18 (new meteorology with old vertical diffusivities), the bias and error for the fine mass species are similar to Run 15. However, a small improvement in the over prediction bias for the carbons leads to the best performance for $PM_{2.5}$. As in Run 17, the coarse mass in Run 18 is quite over predicted, and so the gains made in the fine mode are balanced by worse performance in the coarse mode, and the net PM_{10} error is not too different from Run 15 (+11 μg/m^3, and +17%).

In summary, Run 15 (original meteorology) represents the highest over prediction bias among fine mass species and total PM mass, but the best performance for the coarse mode. Run 17 (new meteorology consistent with the approach for modeling January 1991) represents the best performance for fine mode species and total mass, but possesses an over prediction problem for the coarse mode. The hybrid Run 18 represents a good balance for the fine mass, but continues to over predict the coarse mode. Therefore, no single realization is particularly better for total PM_{10} than any other. However, Run 18 does show that the model is sensitive to the approach for defining vertical mixing rates, as very similar results are achieved between Run 15 and 18 (same diffusivity inputs) even though all other meteorological variables are developed from different MM5 simulations. In other words, it is the different vertical diffusivities in Run 17 that seem to drive most of the PM concentration differences between Run 17 and 15.

6.3.2.2 Episode-Average Mass Budgets

Figure 6-10 presents the episode-mean (December 22-24) PM_{10} and $PM_{2.5}$ mass budgets from observed and simulated species components. Results from Run 15, 17 and 18 are shown for comparison. The sizes of the pie sections indicate the relative contribution to the total mass given at the top of each chart, while the values for each section indicates the absolute episode-mean concentrations. The initial visual conclusion is that the modeling is reproducing the observed fine and total mass budgets well in all runs, and that the differences among the various CAMx configurations are not particularly large. This is a testament to the quality of the estimated emissions inventory. It also indicates that introduction of alternative meteorological fields does not alter the budgets in any profound manner, and this is the expected result.

Closer inspection reveals that the coarse mode is well modeled in Run 15, but is much larger in Runs 17 and 18. As seen in Figure 6-9, the secondary species are slightly under predicted, especially in the latter two runs, but overall the secondary contribution to total mass is on par with measurements. Another performance issue is the high organic contribution in the modeling.

The data used to develop Figure 6-10 was further analyzed to characterize the uncertainty of CAMx results to the meteorological inputs. Table 6-7 presents the average absolute concentration differences among Runs 15 and 17 over the intensive measurement period (December 21-24) for each species and for total aerosol mass. The purpose of this exercise was to quantify the expected level of uncertainty that might arise from using a different configuration of MM5 in the future year scenarios (parallel to Run 17) from that used to develop and analyze the base case performance. The contribution from Run 18 to the uncertainty was not included because it is a meteorological realization that was not run for the future year scenarios. Certainly, the numbers shown in Table 6-7 are dependent upon the particular conditions of the December 1999 episode.

Table 6-7. Estimated uncertainty associated with varying the meteorological inputs in the December 1999 base case.

Species	Uncertainty ($\mu g/m^3$)
Sulfate	± 0.6
Nitrate	± 1.7
Ammonium	± 0.7
Organic C	± 9.1
Elemental C	± 3.1
Other Fine Mass	± 2.0
Total $PM_{2.5}$	± 16.7
Coarse Mass	± 4.4
Total PM_{10}	± 14.8

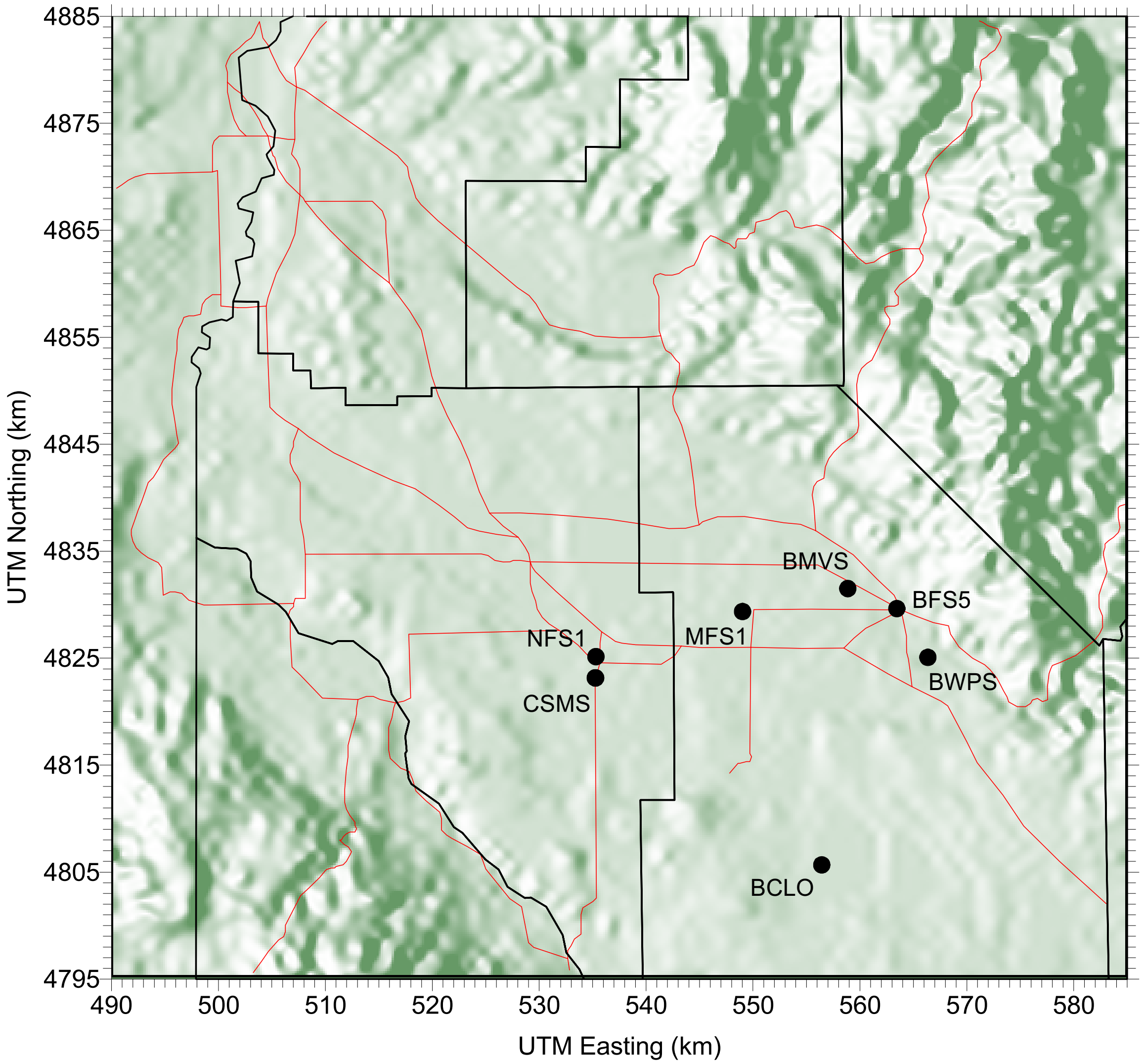


Figure 6-1. Locations of PM monitoring sites within the modeling domain.

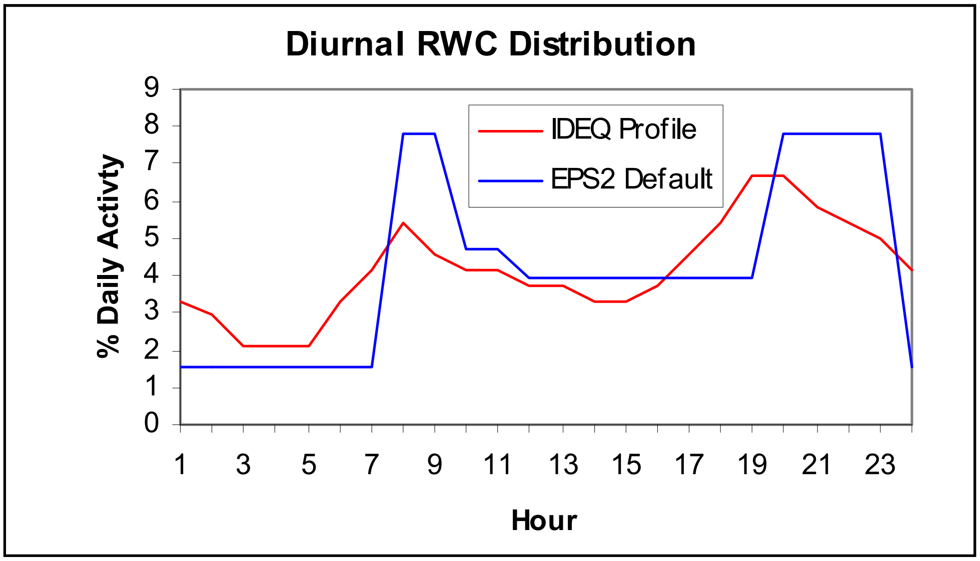


Figure 6-2. Diurnal activity profile used for residential wood combustion source categories. The red line is the IDEQ profile used in final base case simulation; the blue line is the EPS2 default profile originally applied.

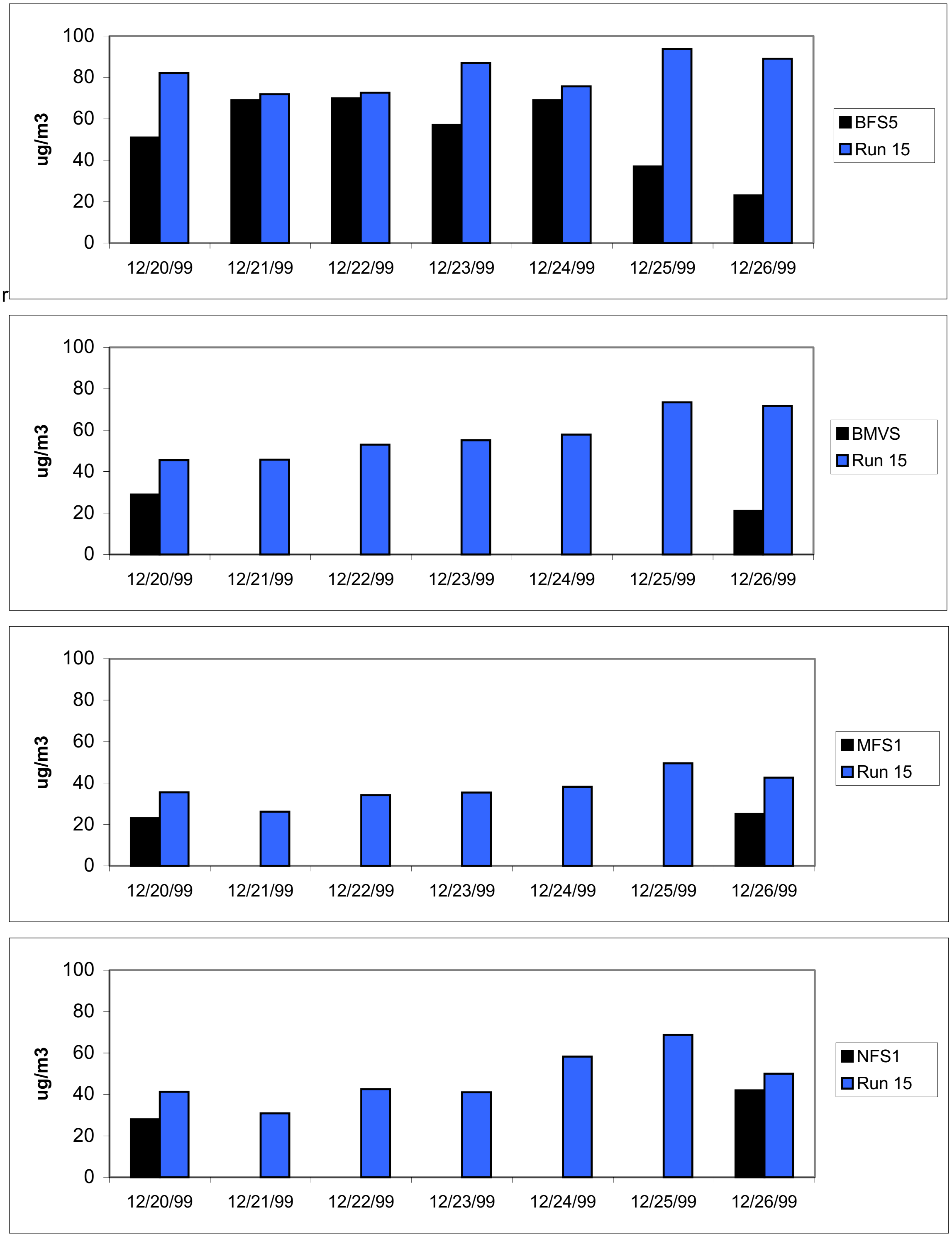


Figure 6-3. Observed (black) and Run 15 predicted (blue) 24-hour PM_{10} at BFS5, BMVS, MFS1, and NFS1 over the December 20-26, 1999 modeling episode.

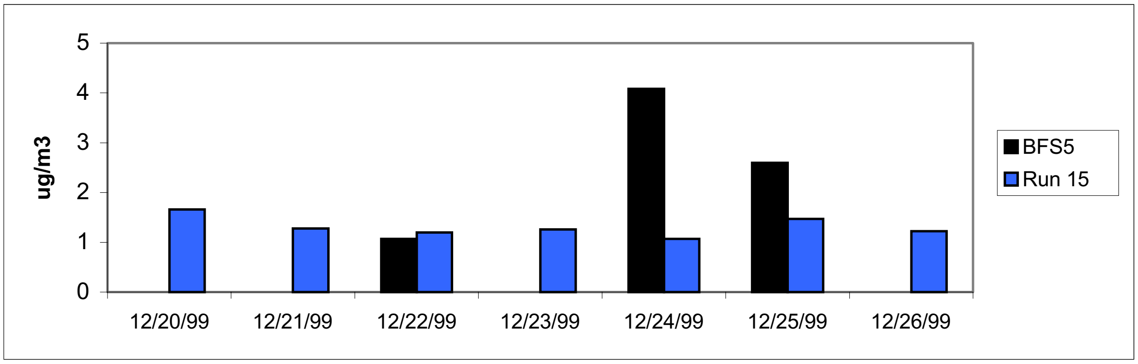


Figure 6-4(a). As in Figure 6-3, but for sulfate at BFS5.

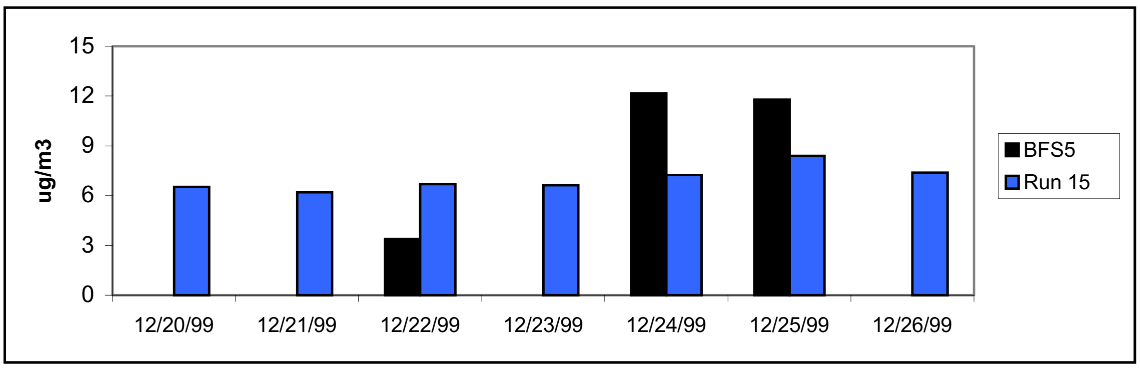


Figure 6-4(b). As in Figure 6-3, but for nitrate at BFS5.

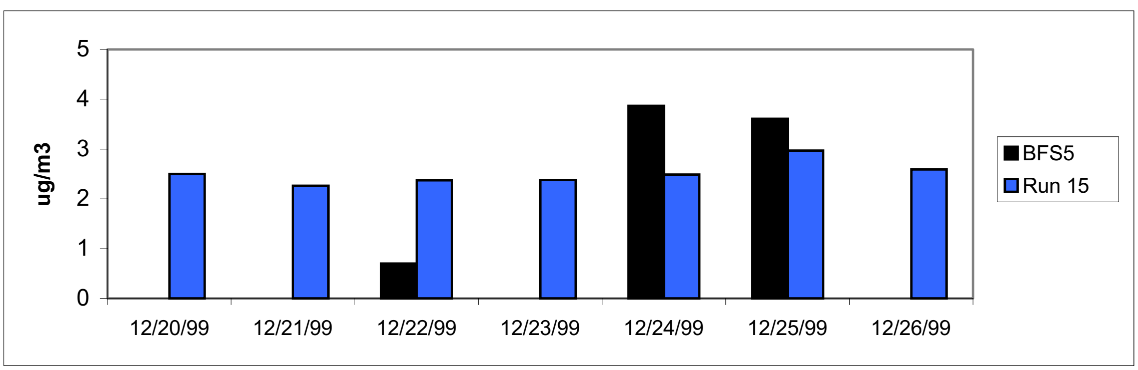


Figure 6-4(c). As in Figure 6-3, but for ammonium at BFS5.

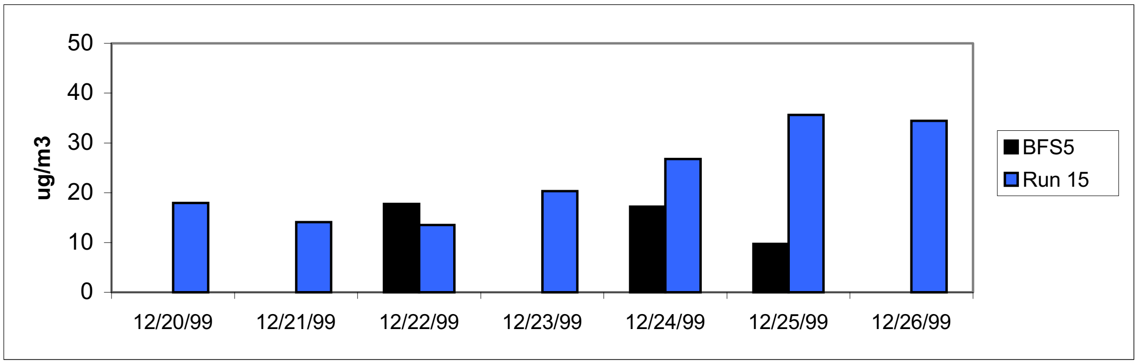


Figure 6-4(d). As in Figure 6-3, but for organic carbon at BFS5.

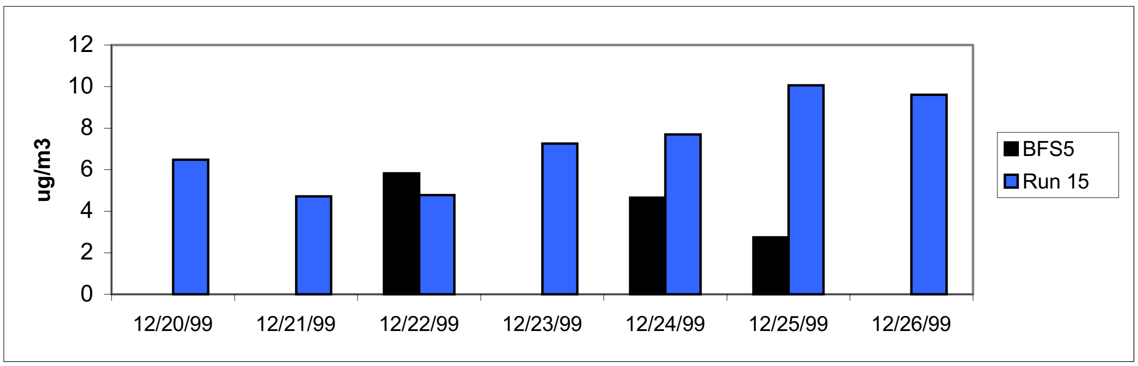


Figure 6-4(e). As in Figure 6-3, but for elemental carbon at BFS5.

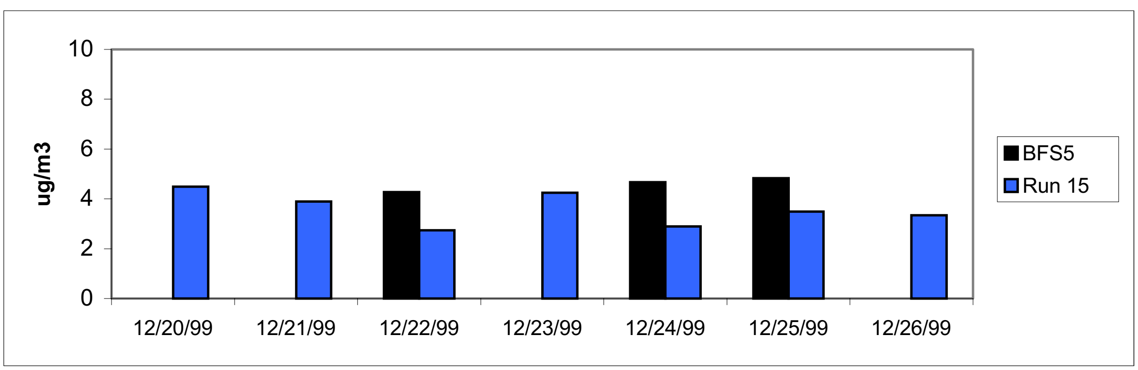


Figure 6-4(f). As in Figure 6-3, but for other fine mass at BFS5.

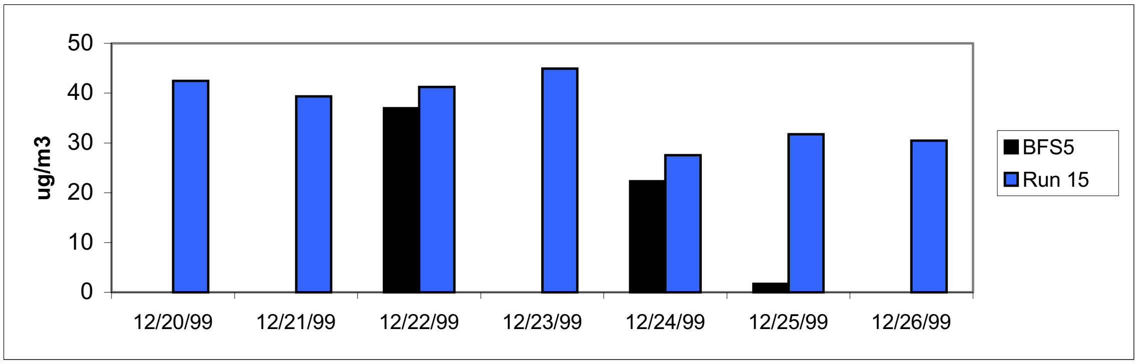
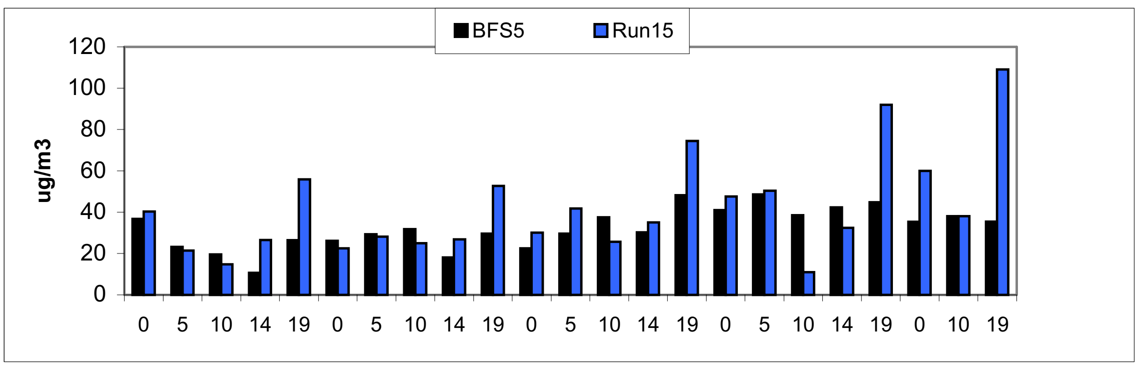


Figure 6-4(g). As in Figure 6-3, but for coarse mass at BFS5.



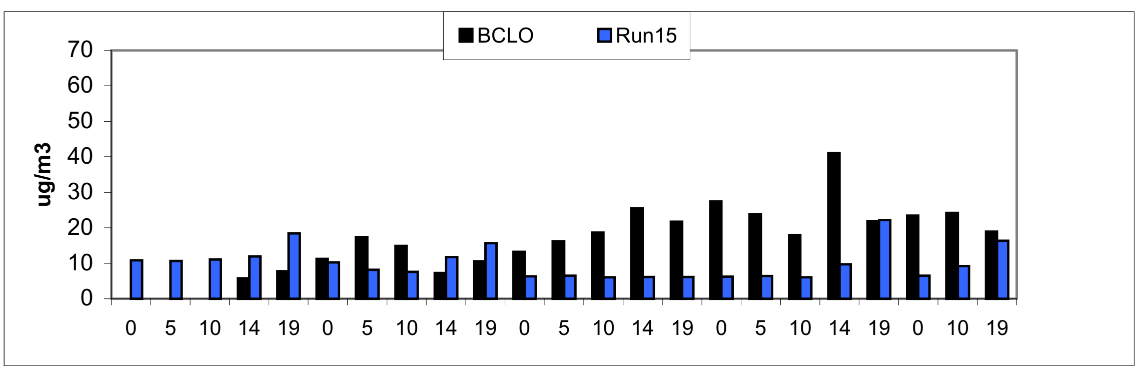


Figure 6-5. High frequency observed (black) and Run 15 predicted (blue) $PM_{2.5}$ at BFS5 and BCLO over December 21-25, 1999. Times at "0" represent local midnight.

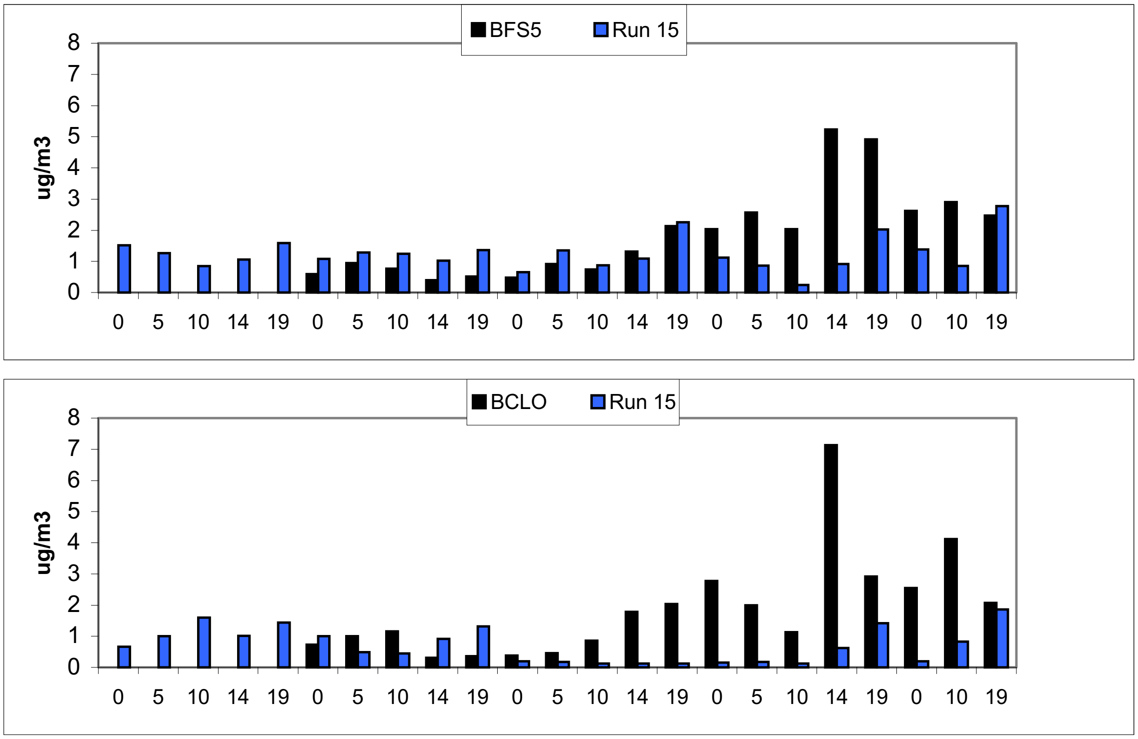


Figure 6-6(a). As in Figure 6-5, but for sulfate.

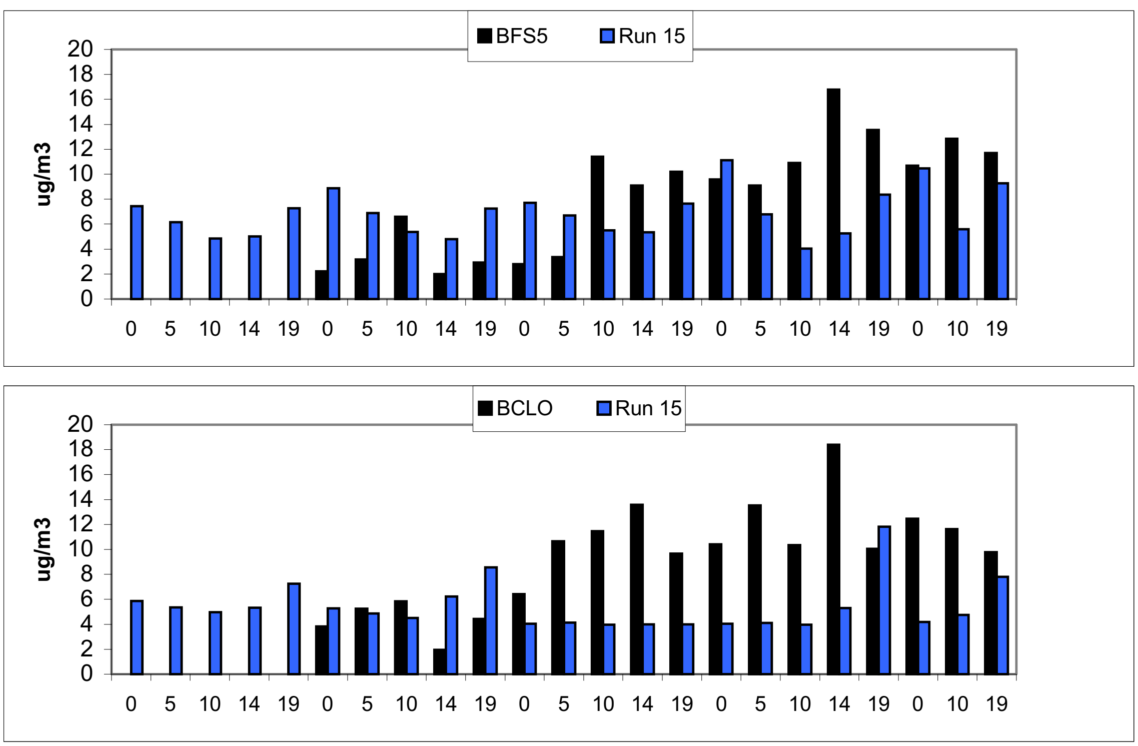


Figure 6-6(b). As in Figure 6-5, but for nitrate.

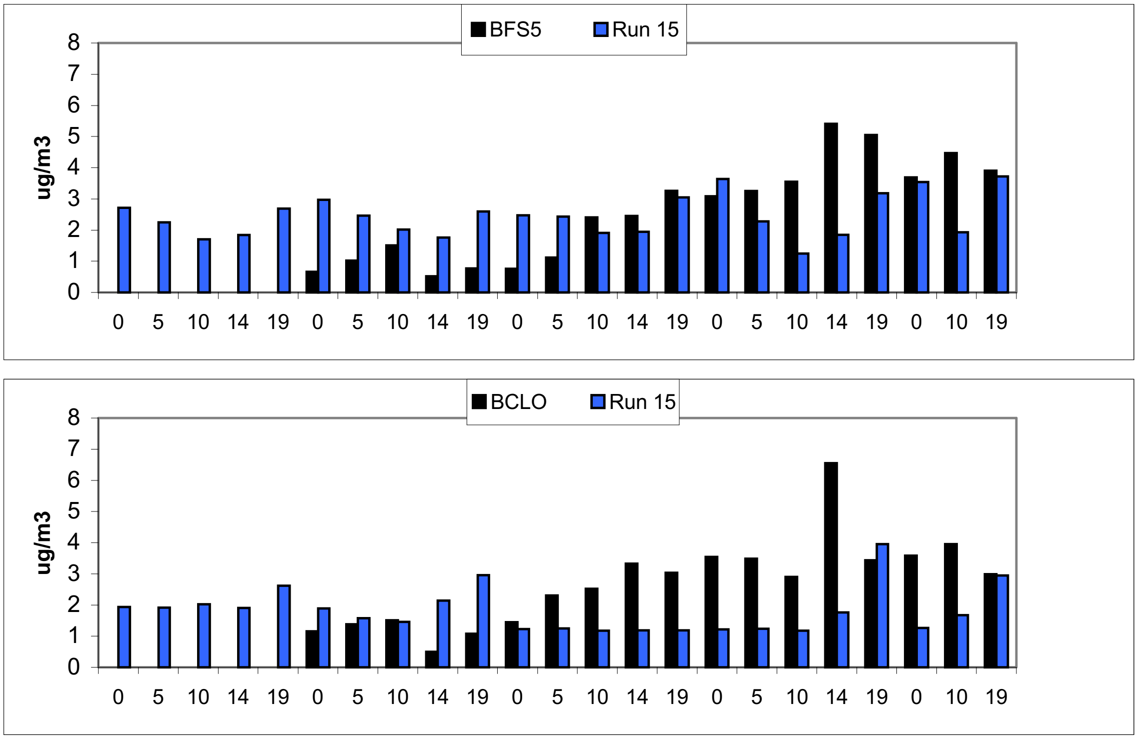


Figure 6-6(c). As in Figure 6-5, but for ammonium.

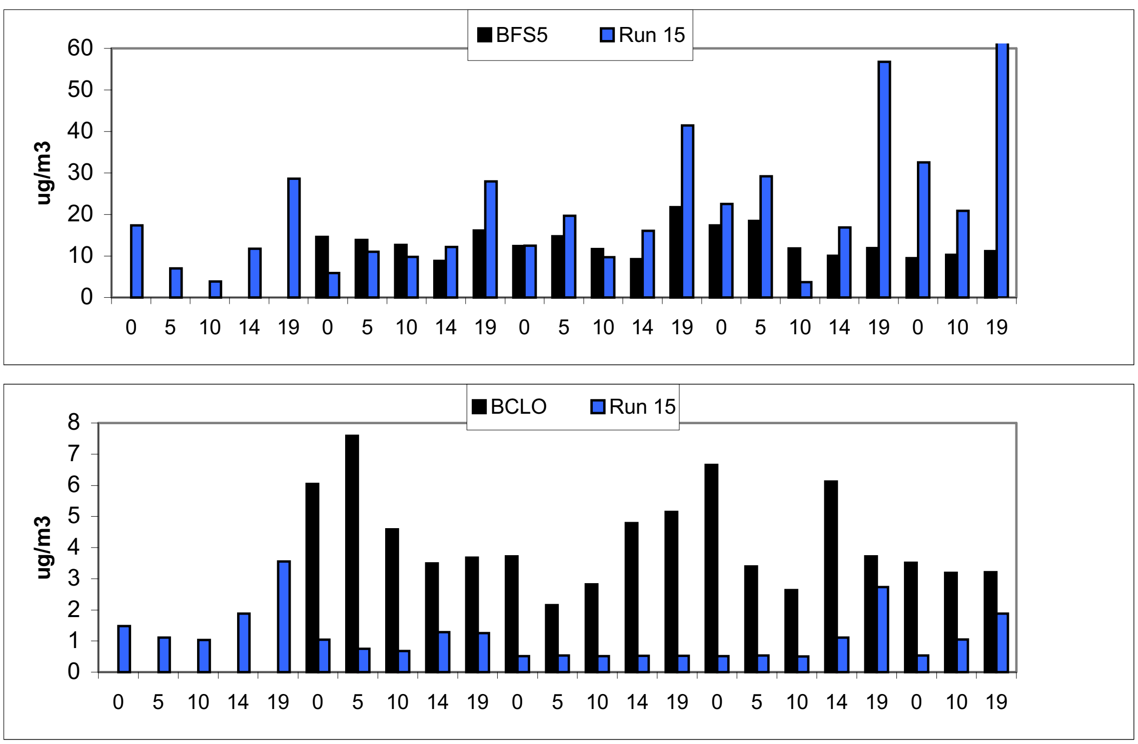


Figure 6-6(d). As in Figure 6-5, but for ammonium.

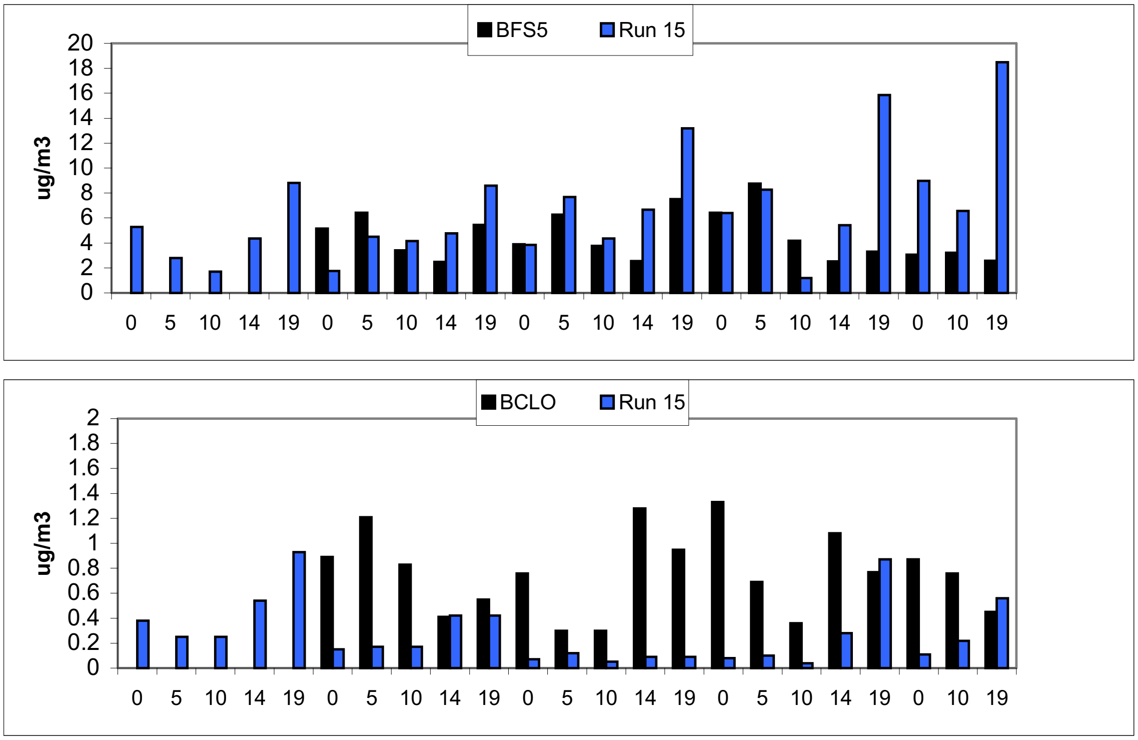


Figure 6-6(e). As in Figure 6-5, but for elemental carbon.

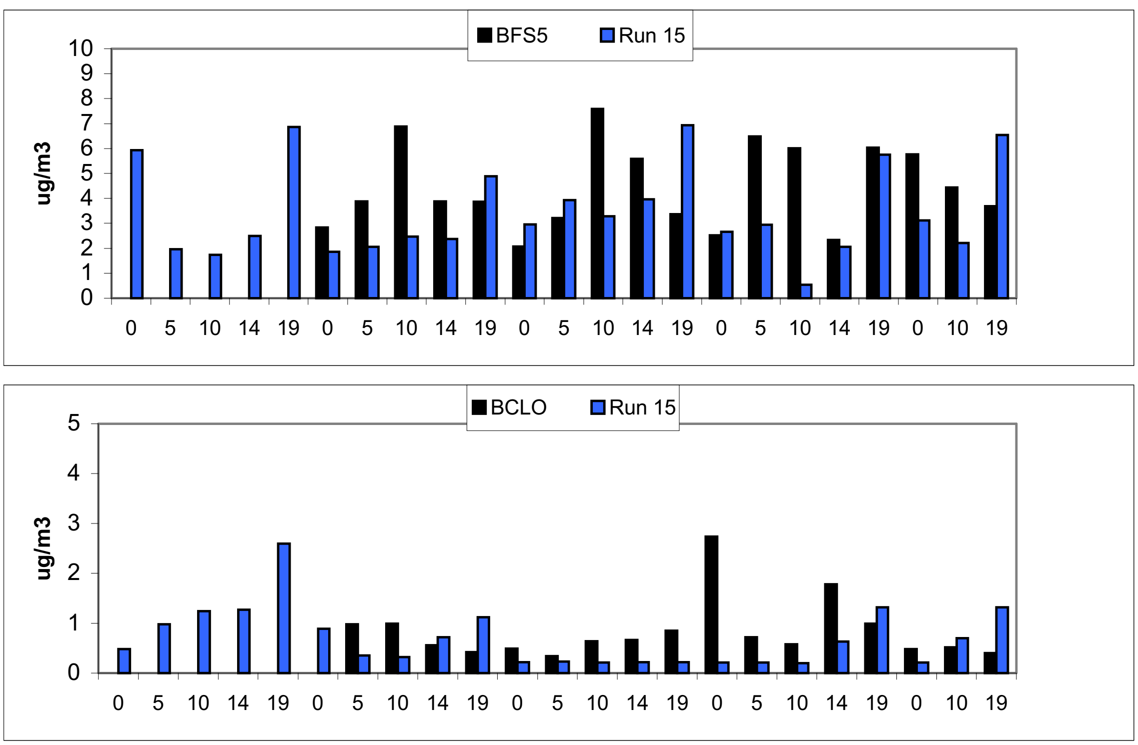


Figure 6-6(f). As in Figure 6-5, but for other fine mass.

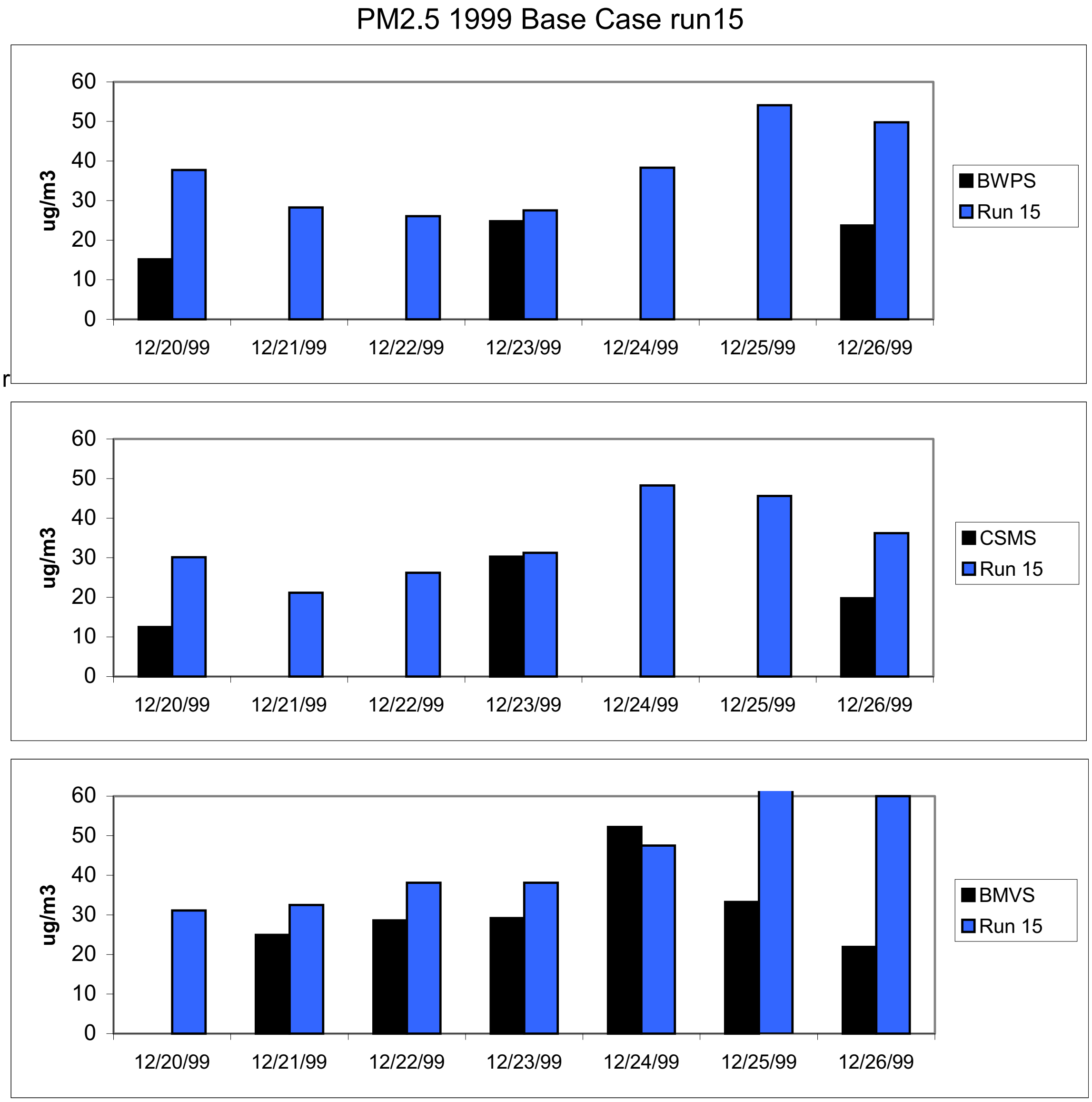


Figure 6-7. Observed (black) and Run 15 predicted (blue) 24-hour $PM_{2.5}$ at BWPS, CSMS, and BMVS over the December 20-26, 1999 modeling episode.

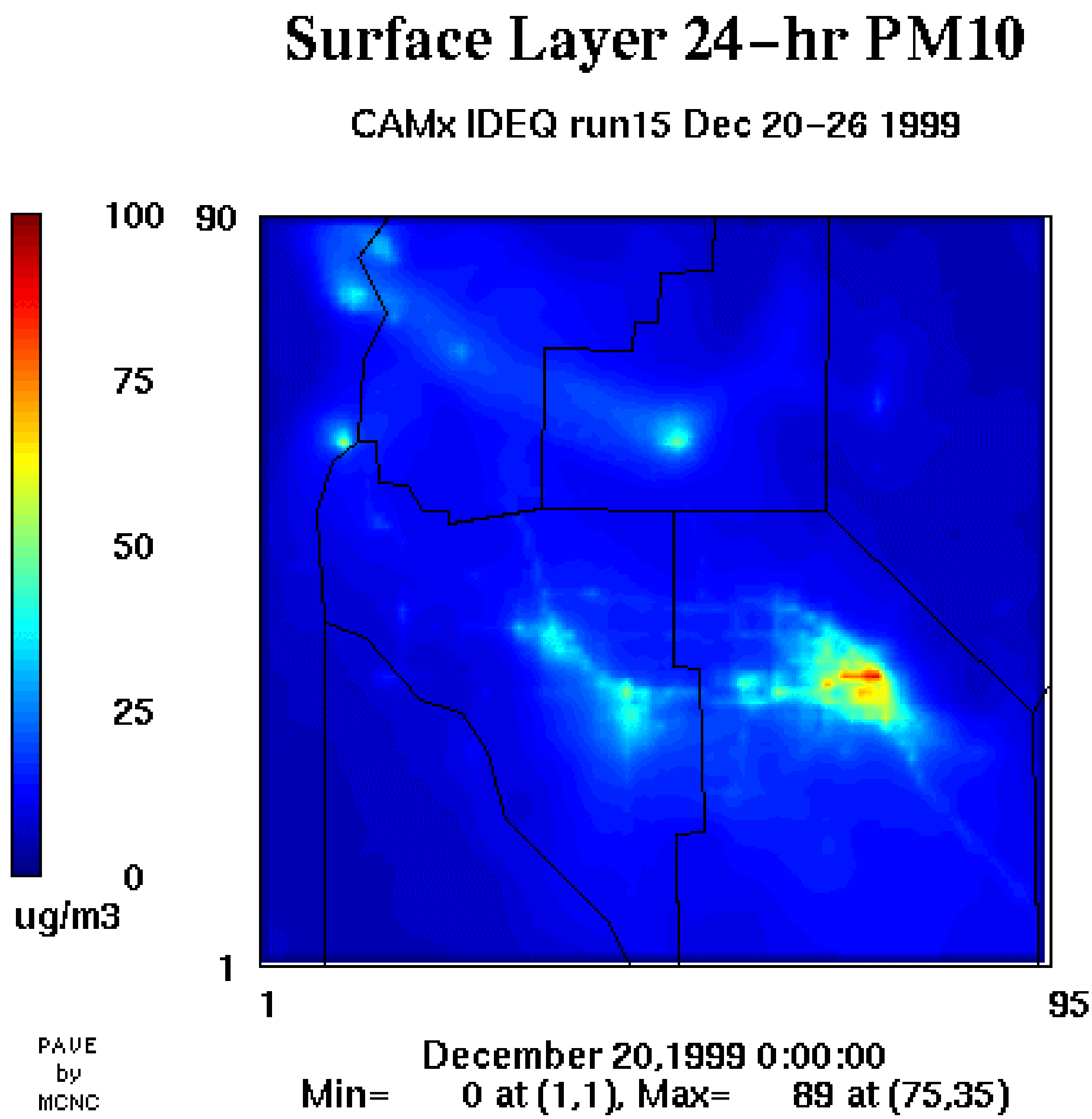


Figure 6-8(a). Spatial distribution of Run 15 predicted 24-hour PM_{10} on December 20, 1999.

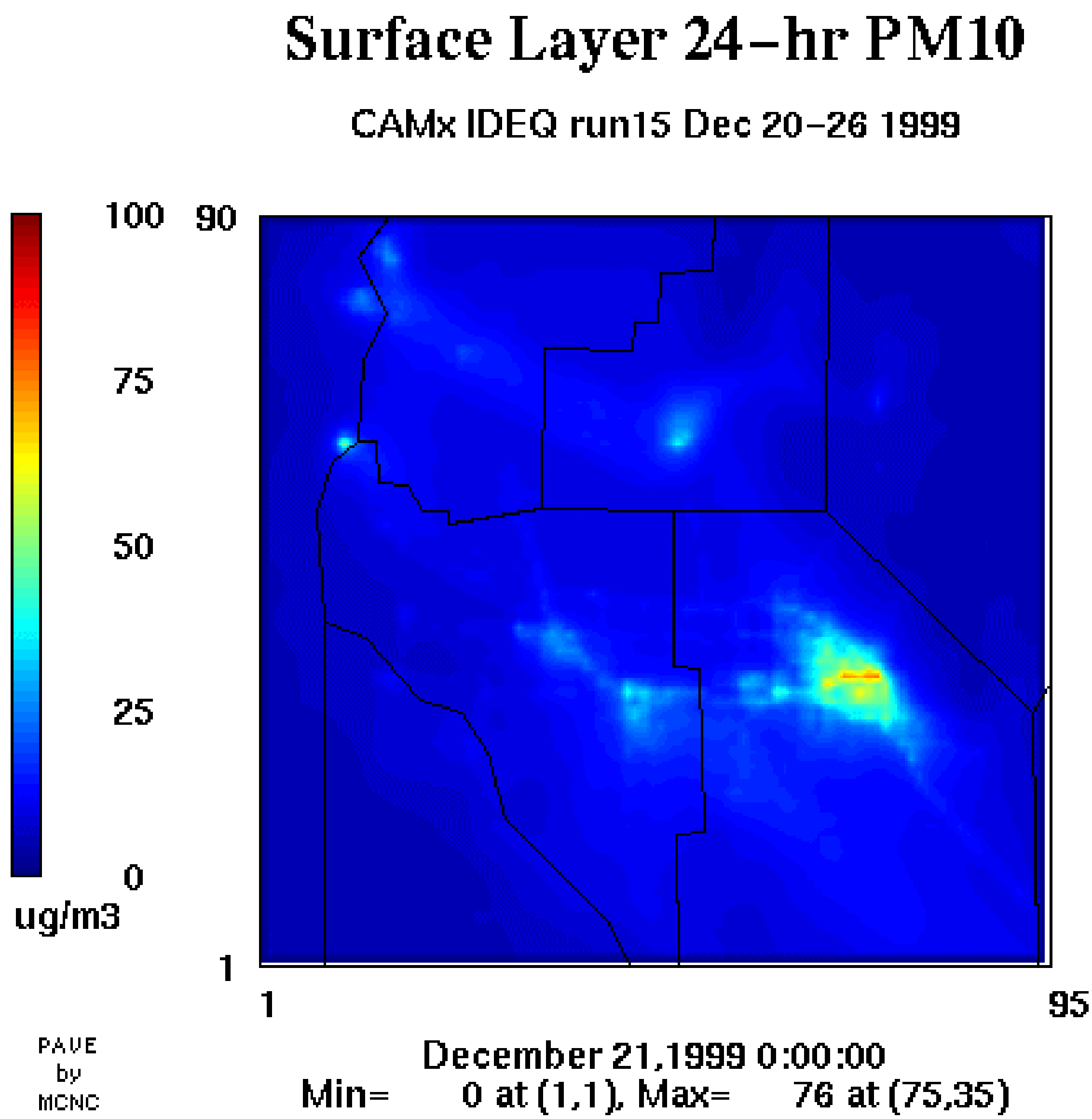


Figure 6-8(b). Spatial distribution of Run 15 predicted 24-hour PM_{10} on December 21, 1999.

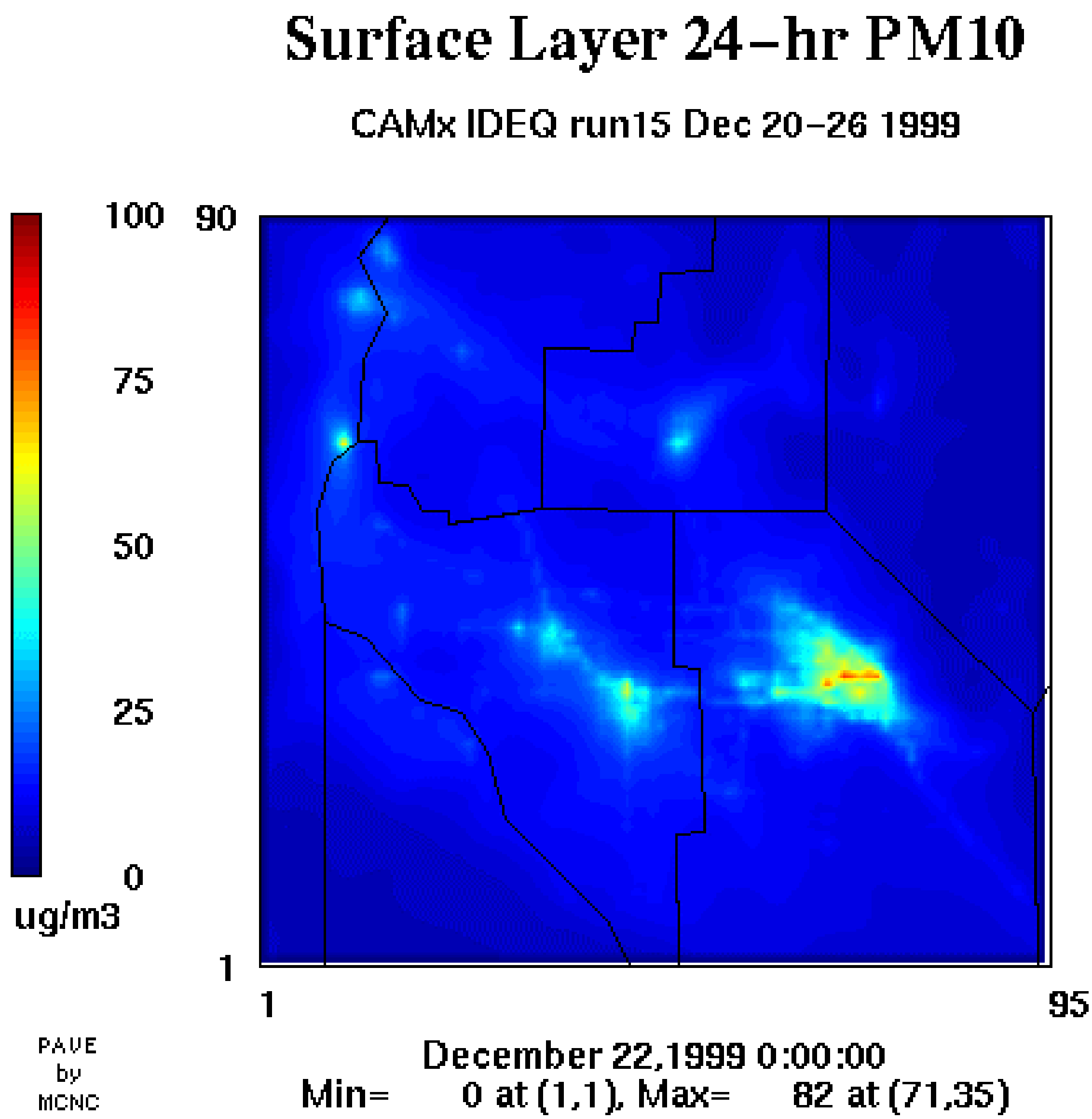


Figure 6-8(c). Spatial distribution of Run 15 predicted 24-hour PM_{10} on December 22, 1999.

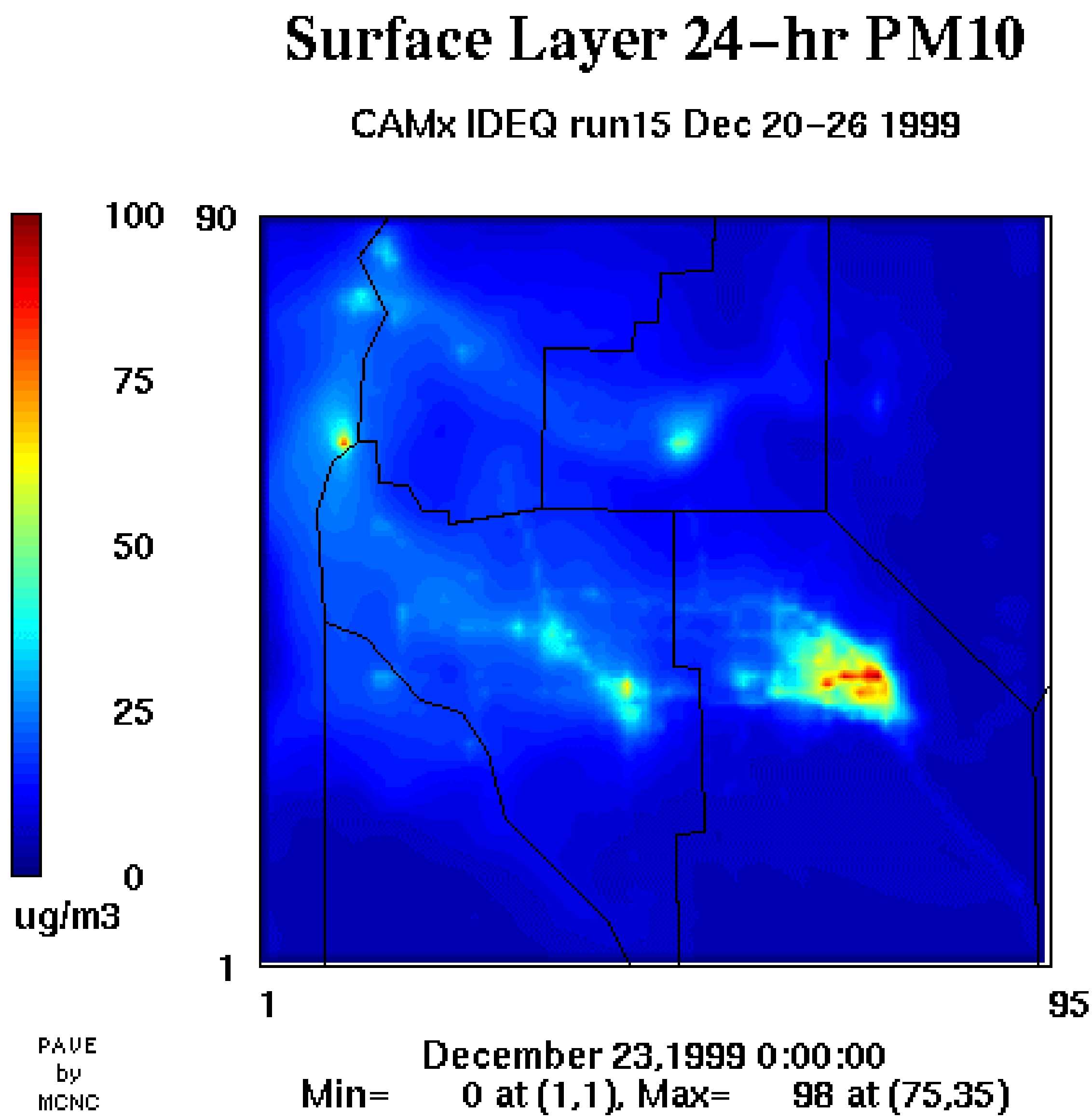


Figure 6-8(d). Spatial distribution of Run 15 predicted 24-hour PM_{10} on December 23, 1999.

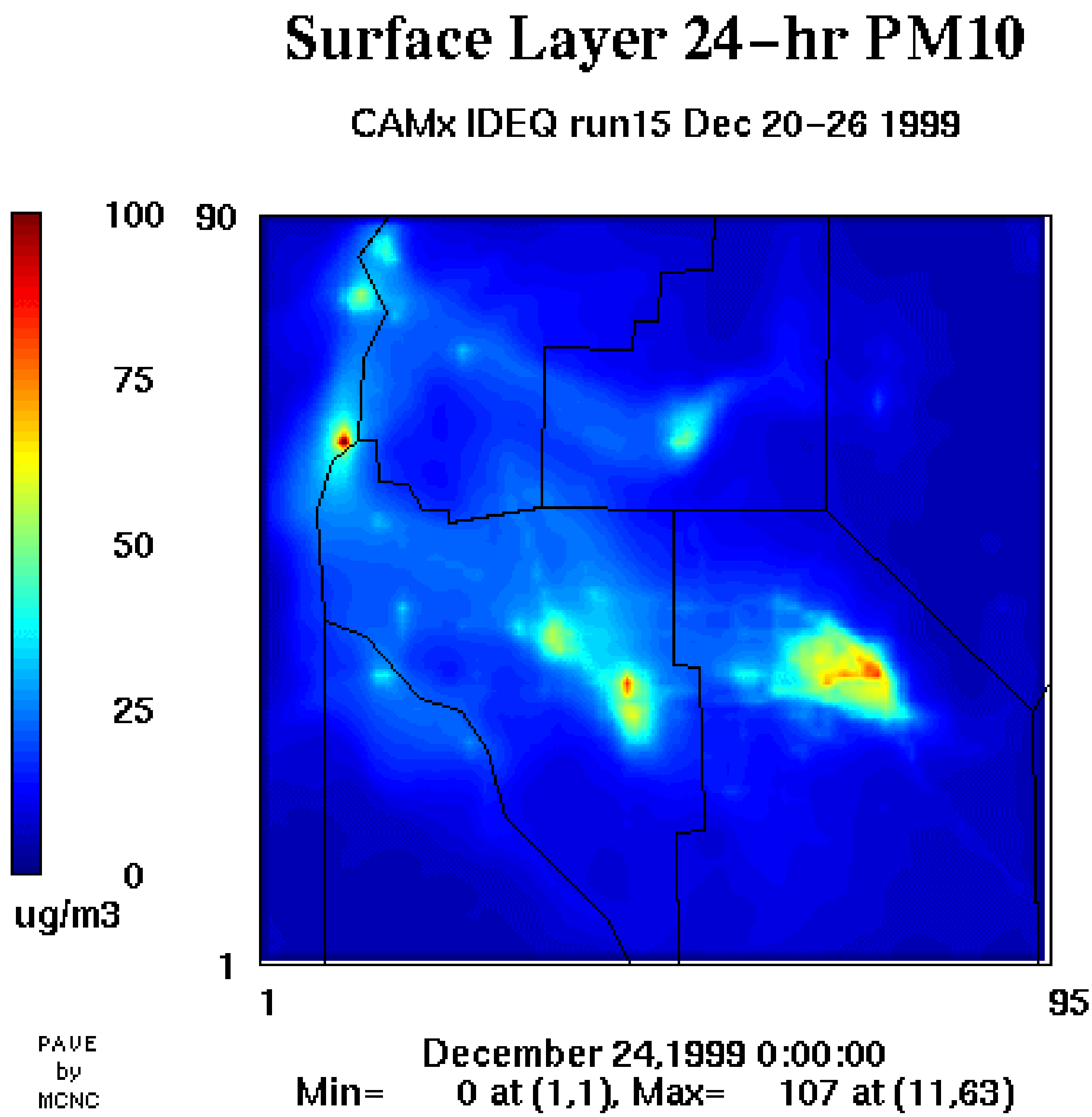


Figure 6-8(e). Spatial distribution of Run 15 predicted 24-hour PM_{10} on December 24, 1999.

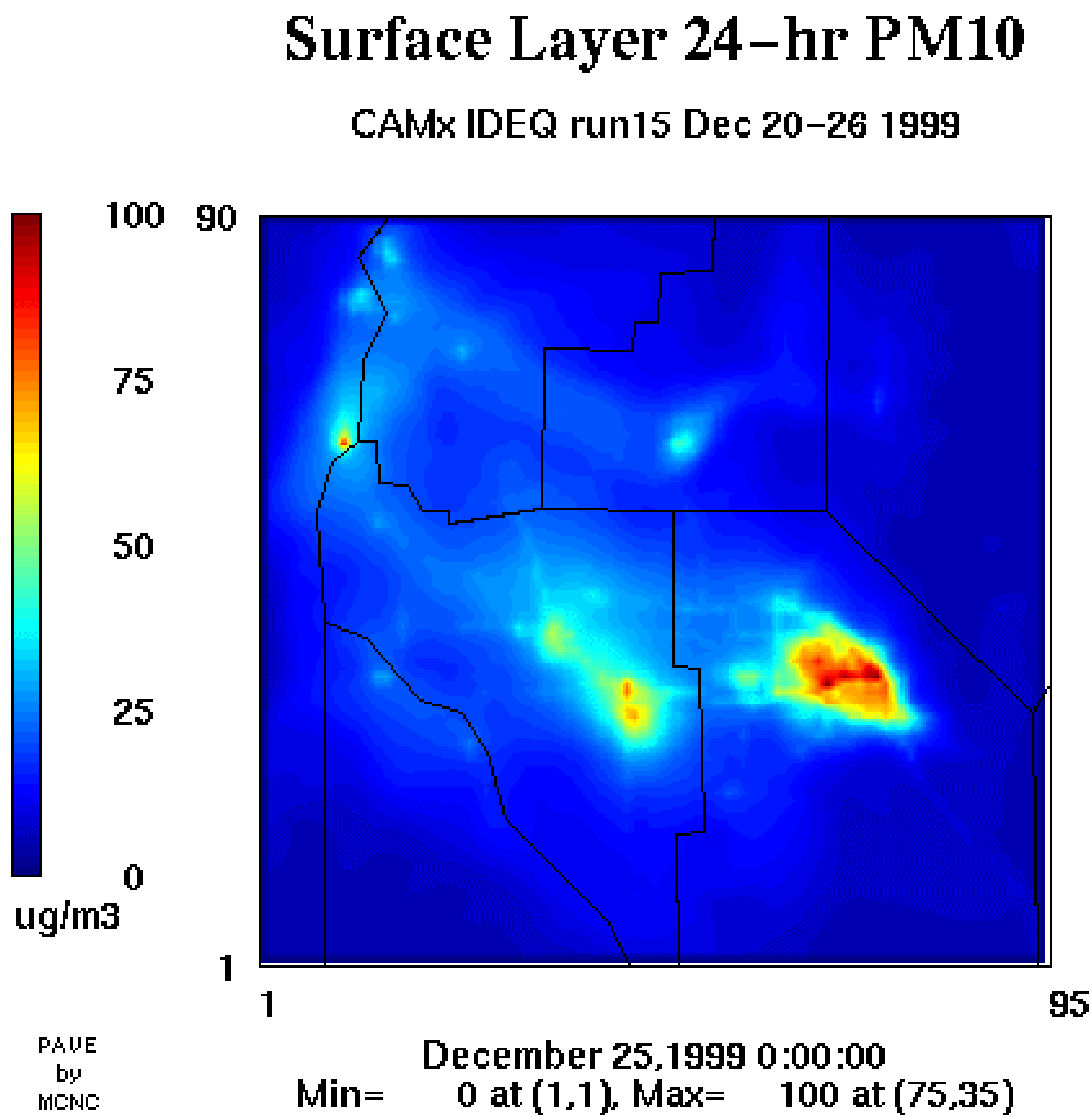


Figure 6-8(f). Spatial distribution of Run 15 predicted 24-hour PM_{10} on December 25, 1999.

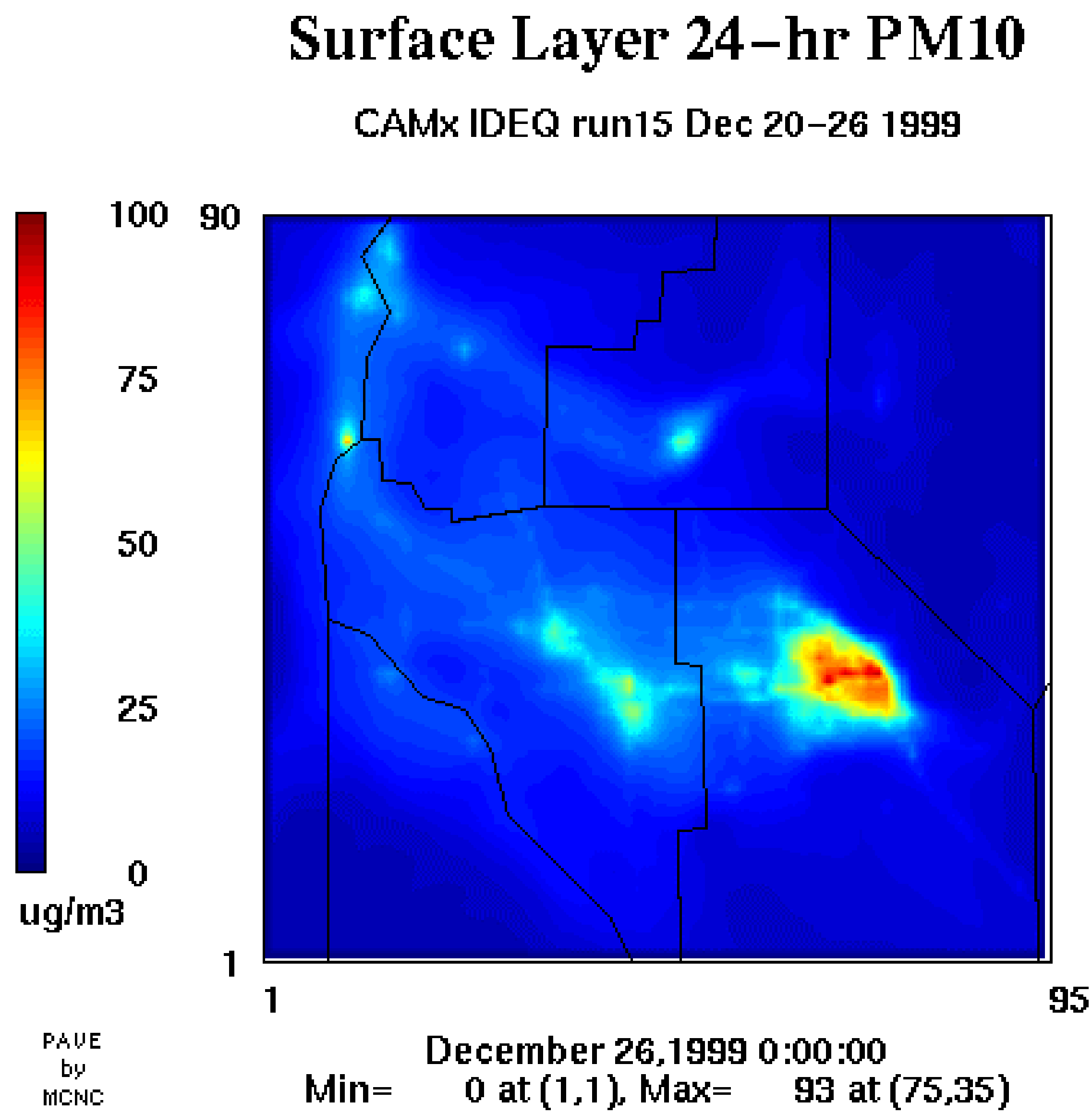


Figure 6-8(g). Spatial distribution of Run 15 predicted 24-hour PM_{10} on December 26, 1999.

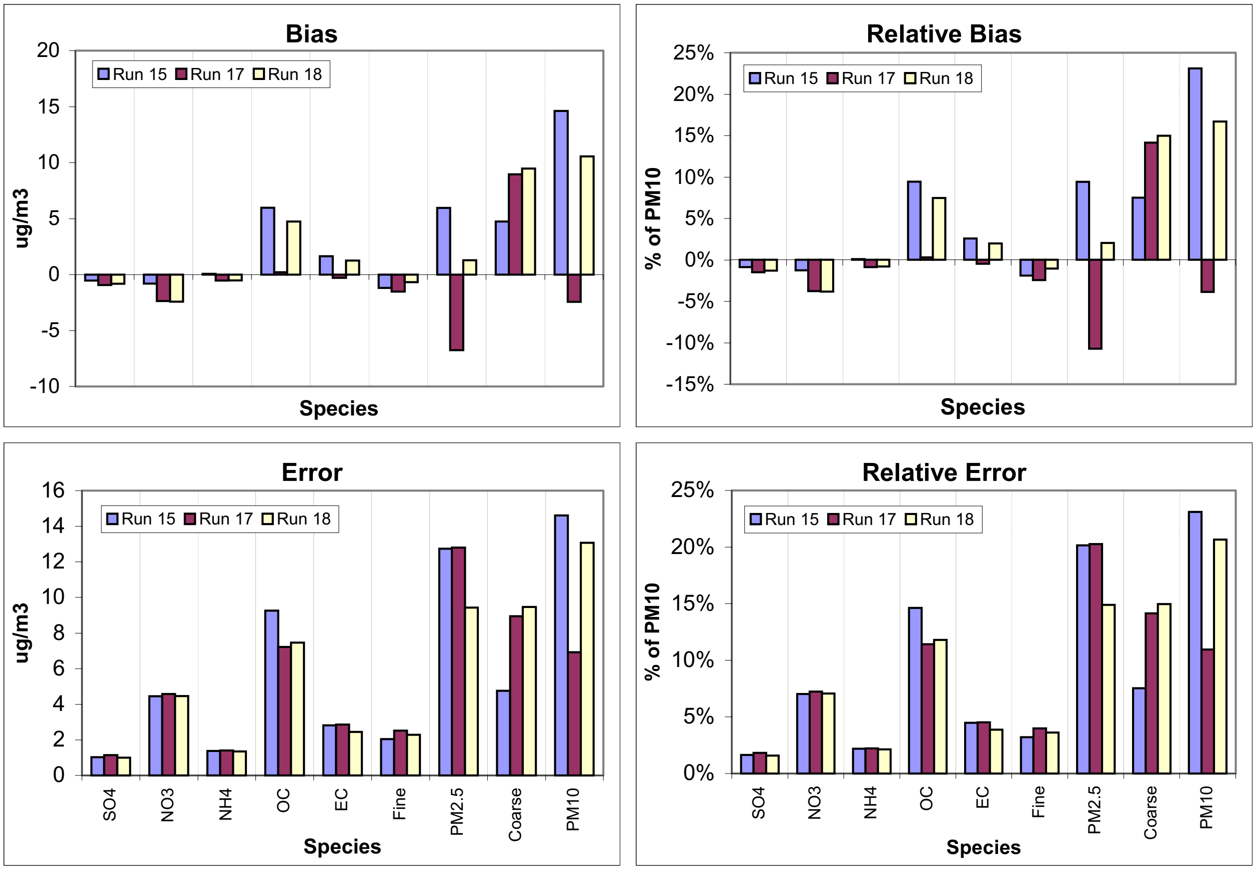


Figure 6-9. Average absolute and relative prediction error (bias and gross) at BFS5 by species over December 22-24, 1999, and for total $PM_{2.5}$ over December 21-24, and for total PM_{10} over December 20-24. The percent errors are relative to total mean observed PM_{0} over December 20-24.

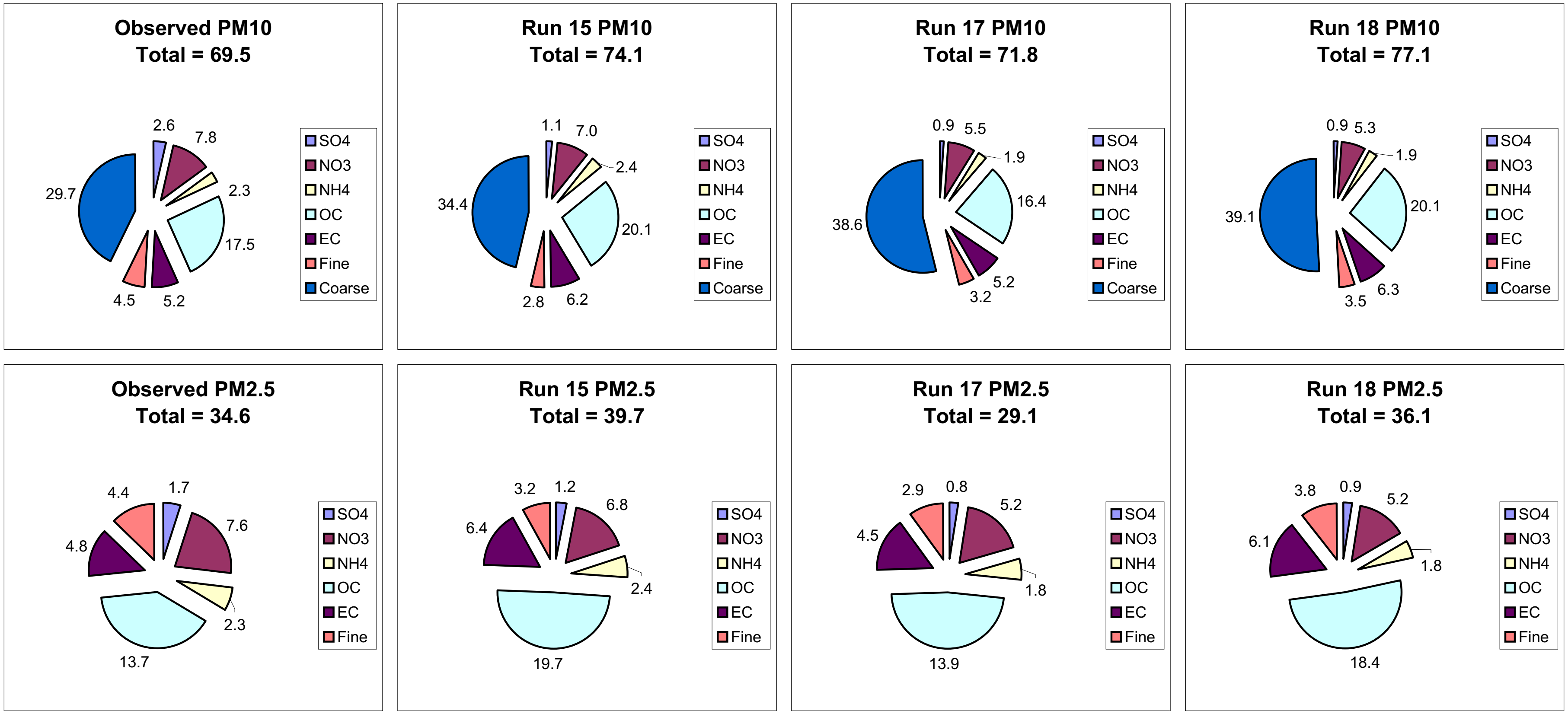


Figure 6-10. Averaged observed and predicted (Runs 15, 17, and 18) $PM_{2.5}$ and PM_{10} mass budgets over December 22-24, 1999. Total PM mass is shown at the top of each plot. The sizes of each pie section show the relative contribution to the total, while the numbers associated with each section show the absolute concentration.

7.0 EPISODIC MAINTENANCE DEMONSTRATION MODELING

The purpose of future year dispersion modeling is to estimate the air quality conditions that result from projections of PM and precursor emission patterns, and to demonstrate whether current emission control plans are sufficient to maintain PM_{10} levels below the 24-hour and annual standards. For the Ada County demonstration, the maintenance period extends through 2015; thus, modeling was performed using emission projections for 2015, and two additional years (2010 and 2020) to evaluate conditions during an intermediate year and an out year for consistency with the PM conformity schedule.

Future year episodic modeling was based on the January 1991 meteorological conditions that resulted in the last PM_{10} exceedance in Ada County. Meteorology was modeled with MM5 for this period as described in the supplemental Meteorological Modeling report (MM5 "Run 11"), and episodic gridded model-ready emission inputs were developed based on estimated activity in the 2010, 2015, and 2020 years (see the Emissions Inventory report). CAMx was used to combine the January 1991 "worst-case" meteorology with the future year episodic emission projections to estimate the PM_{10} conditions in the basin. Resulting PM distributions were analyzed to determine if PM_{10} concentrations in Ada County would exceed the 24-hour standard in these years if the worst-case conditions were to occur again. CAMx was also run with the 1999 meteorology in conjunction with the future year emission inventories as an additional check for maintenance, and as a way to provide a more consistent approach between the base year performance evaluation and the future year attainment modeling.

Initial modeling of the future years utilized emission estimates at their full estimated future capacity (see the Emissions Inventory report); no special episodic control measures were included. The results suggested that the full inventories in all three years would yield PM_{10} concentrations in exceedance of the 24-hour standard in Ada County. Therefore, the CAMx runs were repeated with episodic voluntary wood-burning bans following procedures in accordance with generally how the ban would be called by the IDEQ. With the burn ban in place, maintenance of the 24-hour standard was demonstrated for Ada County. Details of the approach and results of theses analyses are presented in the following sections.

7.1 PM_{10} ESTIMATES WITH UNCONTROLLED INVENTORY

The "uncontrolled" emissions inventory refers to a lack of specific short-term episodic controls for Ada County, but the inventory does include all established and promulgated long-term emission reductions such as I/M programs, fireplace building codes, federal-level rules on mobile sources, etc. (see the Emissions Inventory report). CAMx was run for January 2-9, 1991 using future year emission inventories for 2010, 2015, and 2020. It should be noted that to reflect the mitigating effects of snow cover when modeling with January 1991 meteorology, the full paved road dust emission rates were scaled down by a factor of 2.4 (based upon receptor modeling results, see the supplemental Emissions Inventory report), and unpaved road dust emissions were completely removed (Etyemezian et al., 2001). CAMx was also run for the December 20-24, 1999 period with the future year inventories, except in that case the full road dust rates were included due to lack of snow.

Table 7-1 displays the predicted peak 24-hour PM_{10} in Ada County for each day of the episodes. For the January 1991 period, the maximum modeled concentration occurs on January 5 in all three future years (170, 188, and 193 µg/m^3); this is the only day in which the estimates are above the 24-hour standard of 150 µg/m^3. The maximum modeled concentrations over the December 1999 period all occur on December 24 (127, 139, and 143 µg/m^3). No days in the December episode are predicted to be over the standard in any future year.

Table 7-1. Predicted peak 24-hour PM_{10} (µg/m^3) anywhere in Ada County in three future years over the January 1991 and December 1999 meteorological episodes.

Date	2010	2015	2020
January 1991 Episode			
Jan 2	96	98	99
Jan 3	101	105	110
Jan 4	109	113	119
Jan 5	170	188	193
Jan 6	100	110	114
Jan 7	46	48	51
Jan 8	121	122	124
Jan 9	48	50	53
December 1999 Episode			
Dec 20	110	114	117
Dec 21	78	84	88
Dec 22	84	88	95
Dec 23	96	104	110
Dec 24	127	139	143

Figures 7-1 and 7-2 display the simulated domain-wide distribution of 24-hour PM_0 on January 5 and December 24, respectively, for all three future years. Figures 7-3 and 7-4 show the predicted speciated breakdown of PM_{10} at the BFS5 site on January 5 and December 24, respectively, for all three future years. Note that in both episodes the majority of PM_0 is in the organics fraction. The second-highest contribution in the December episode is coarse mass, while in the January episode the second-highest is elemental carbon (due to less road dust).

7.2 PM_{10} ESTIMATES WITH WOOD BURNING BAN

The IDEQ residential wood burning ban program comprises a tiered approach, with a voluntary-based ban triggered at relatively moderate PM_{10} levels, followed by a mandatory ban triggered at higher PM_{10} levels. Specifically, the voluntary burn ban is called for Ada and Canyon Counties when the preceding day's maximum monitored 24-hour PM10 concentration exceeds 74 µg/m^3 at any of the monitors. According to the 1991 SIP for Ada County, the assumed effectiveness of the voluntary reduction is a 43% reduction in residential wood smoke emissions. The mandatory burn ban is called for Ada County only, and is triggered at 100 μg/m^3 and above. The effectiveness of this control is assumed to be 80% (from the 1991 SIP). According to the IDEQ, the voluntary and mandatory bans remain in effect until the IDEQ identifies when the prevailing meteorological conditions improve to end the pollution episode. A ban on open burning is also called for Ada County, Nampa, and Caldwell based on a 74 μg/m^3 trigger, however, this was not considered in the future year analyses as no open burning emissions were included in the modeling inventories.

In the January 1991 case described above (no burn ban), the simulated 24-hour PM_{10} on January 2 at BFS5 exceeded the voluntary trigger in all three future years (83, 89, and 94 μg/m^3). Therefore, the emissions inventory was revised for January 3-9 to include a 43% reduction in residential wood combustion emissions. While the rule calls for a voluntary ban in both Ada and Canyon Counties, controls were only applied to the modeling inventory in Ada County.

In the December 1999 case described above, the simulated 24-hour PM_{10} on December 20 at BFS5 exceeded the voluntary trigger in 2010 and 2015 (93 and 99 μg/m^3), and exceeded the mandatory trigger in 2020 (104 μg/m^3). However, since the simulations of all three future years showed maintenance in Ada County (Table 7-1), additional simulations with burn bans included were not undertaken for the December 1999 period.

Table 7-2 displays the predicted peak 24-hour PM_{10} in Ada County for each day of the January episode when the voluntary burn bans were included in the emissions inventory. Note that the voluntary measure was estimated to be sufficient to maintain the PM_{10} standard in Ada County. On January 5th, predicted concentrations at BFS5 reached 108, 117, and 121 μg/m^3 in the three future years. This would trigger the mandatory burn ban through the remainder of the episode (January 6-9); however, the additional controls were not modeled as the voluntary ban was predicted to be sufficient to reach attainment.

Table 7-2. Predicted peak 24-hour PM_{10} (μg/m^3) in Ada County in three future years over the January 1991 meteorological episode. This case included a 43% voluntary reduction in residential wood smoke emissions in Ada County.

Date	2010	2015	2020
January 1991 Episode			
Jan 2	96	98	99
Jan 3	95	98	103
Jan 4	103	106	111
Jan 5	122	126	130
Jan 6	72	77	81
Jan 7	42	44	47
Jan 8	119	121	122
Jan 9	44	46	49

Figure 7-5 displays the simulated domain-wide distribution of 24-hour PM_{10} on January 5, for all three future years, for the cases shown in Table 7-2. Figure 7-6 shows the speciated breakdown at BFS5 on January 5 for all three future years.

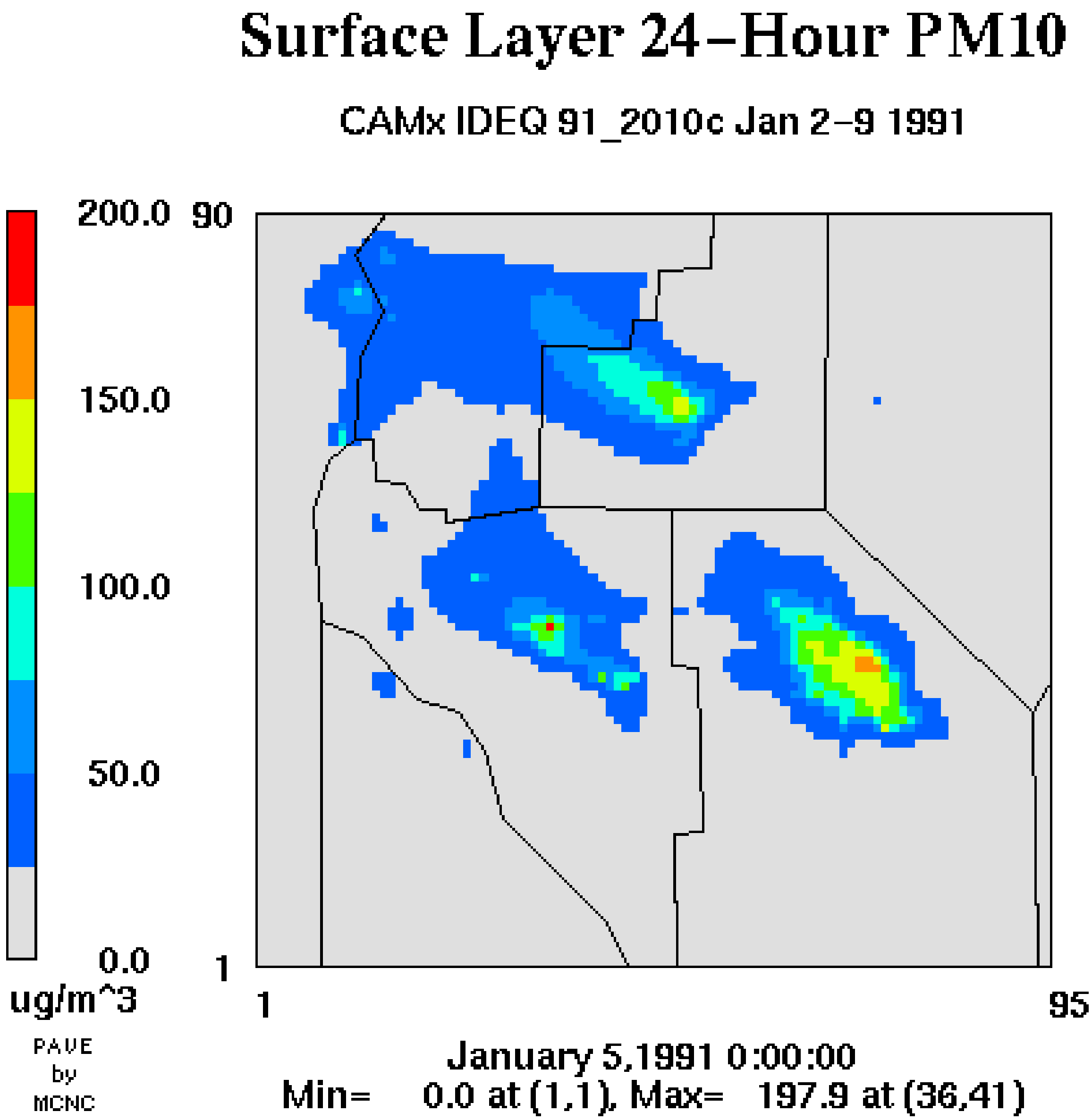


Figure 7-1(a). Spatial distribution of predicted 24-hour PM_{10} on January 5, 1991 for the 2010 future year case.

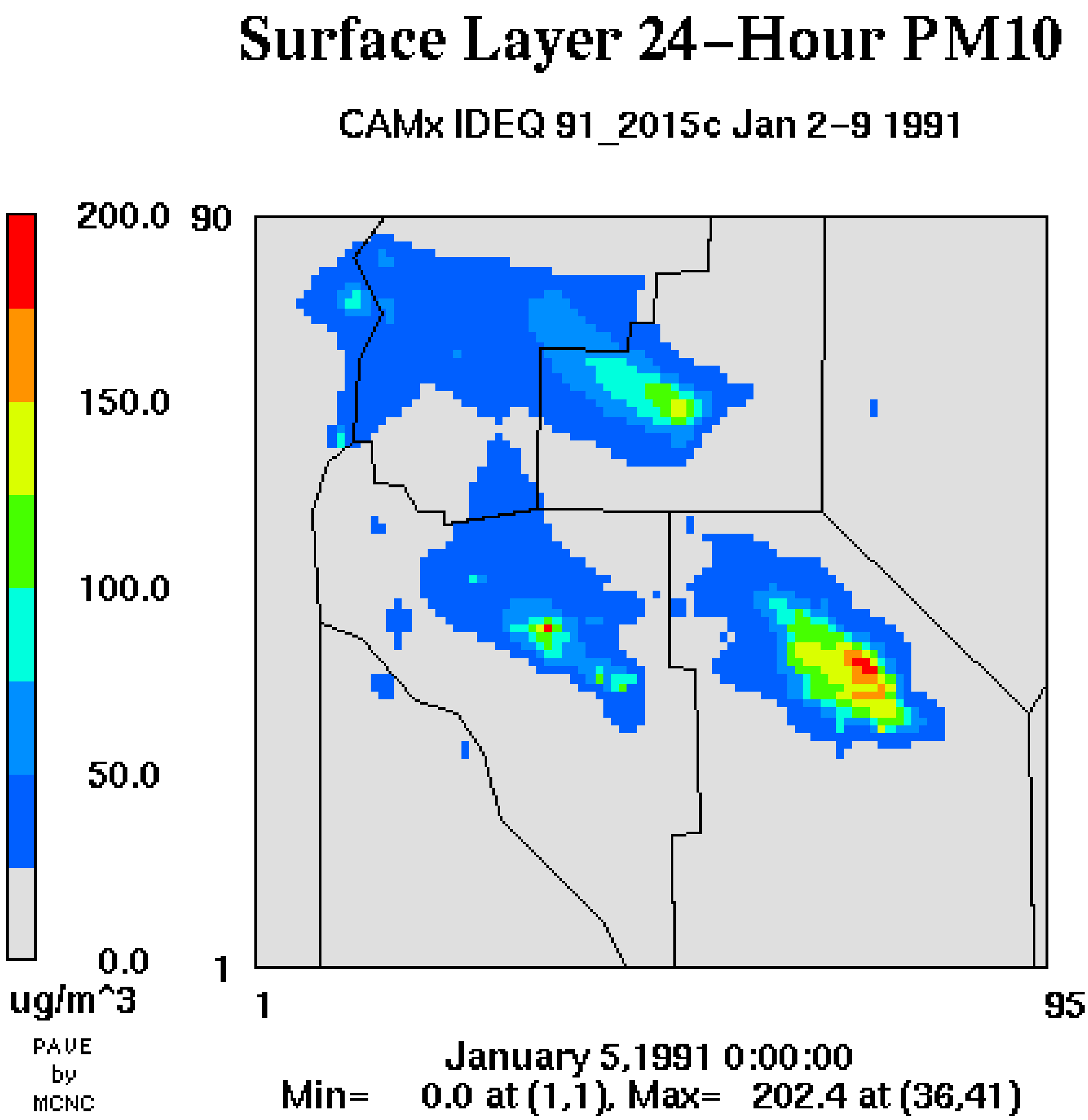


Figure 7-1(b). Spatial distribution of predicted 24-hour PM_{10} on January 5, 1991 for the 2015 future year case.

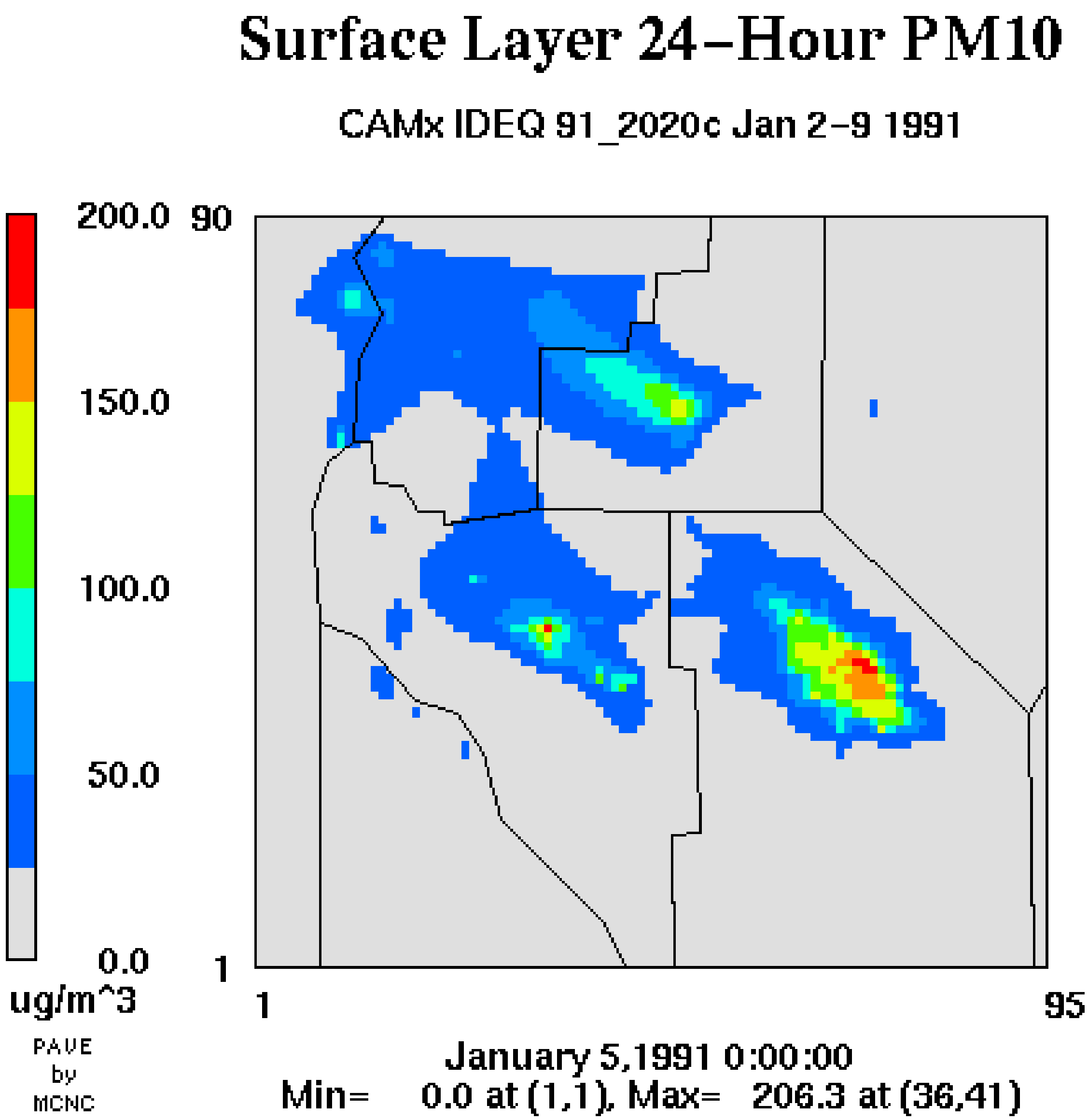


Figure 7-1(c). Spatial distribution of predicted 24-hour PM_{10} on January 5, 1991 for the 2020 future year case.

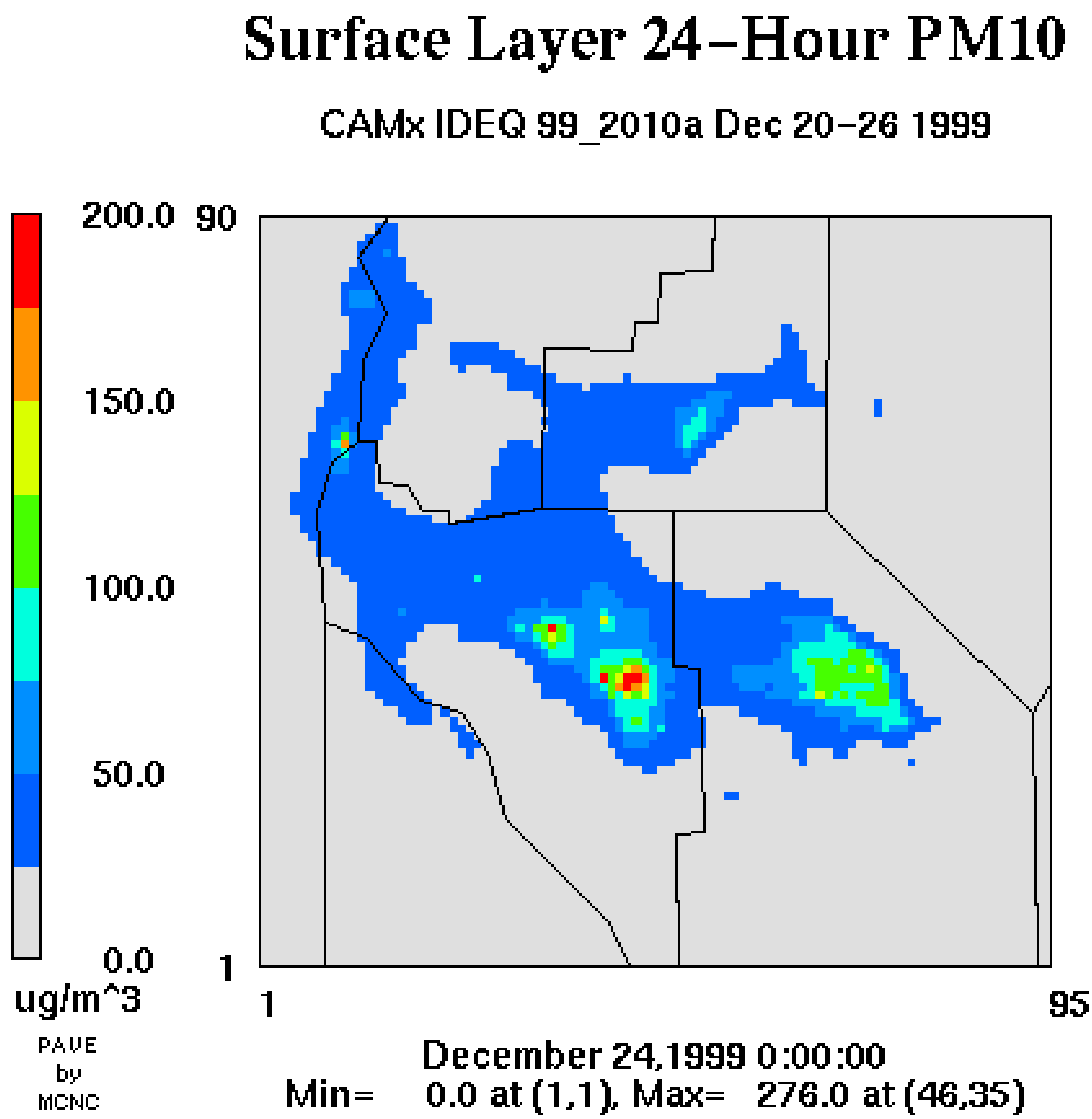


Figure 7-2(a). Spatial distribution of predicted 24-hour PM_{10} on December 24, 1999 for the 2010 future year case.

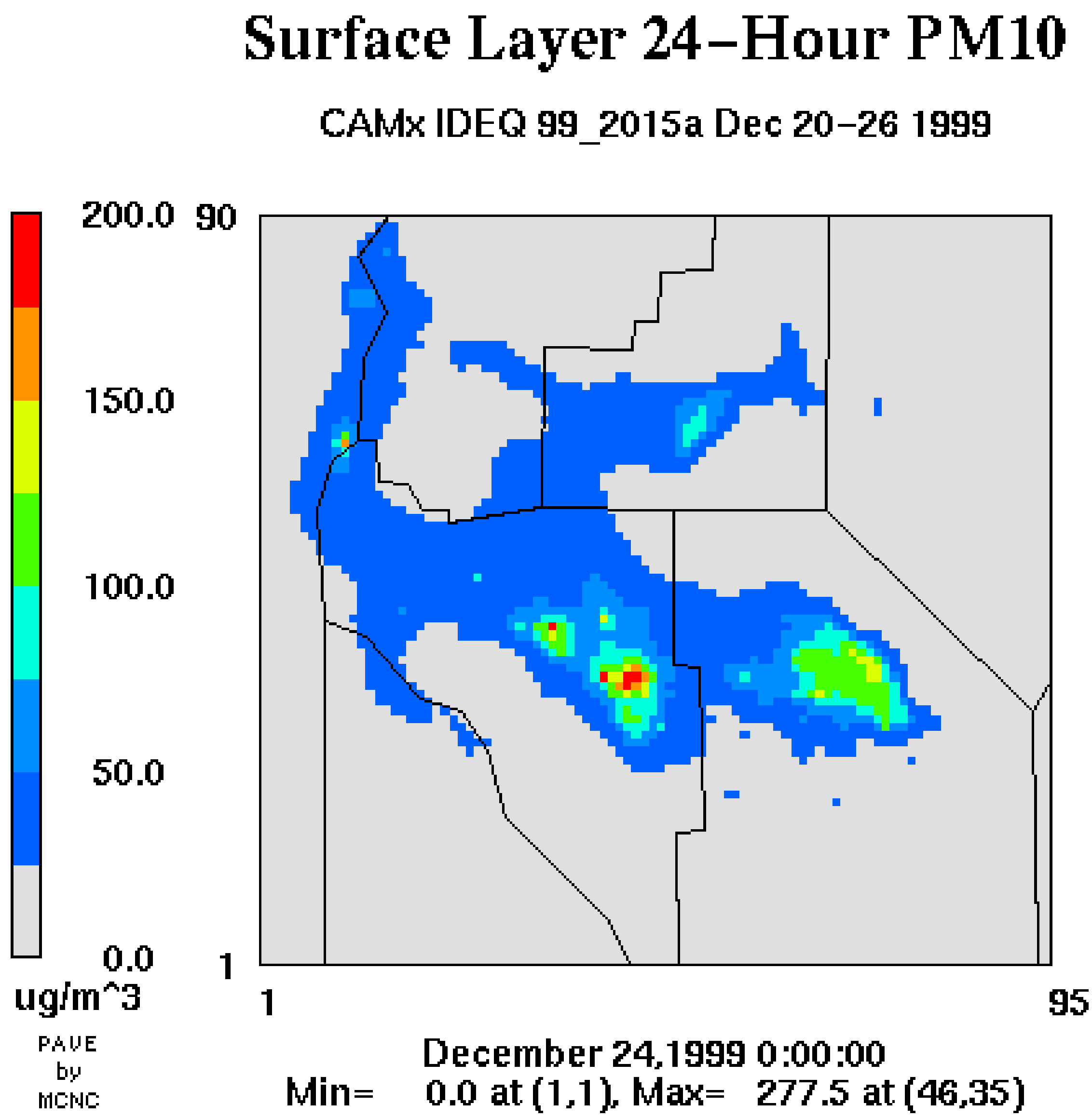


Figure 7-2(b). Spatial distribution of predicted 24-hour PM_{10} on December 24, 1999 for the 2015 future year case.

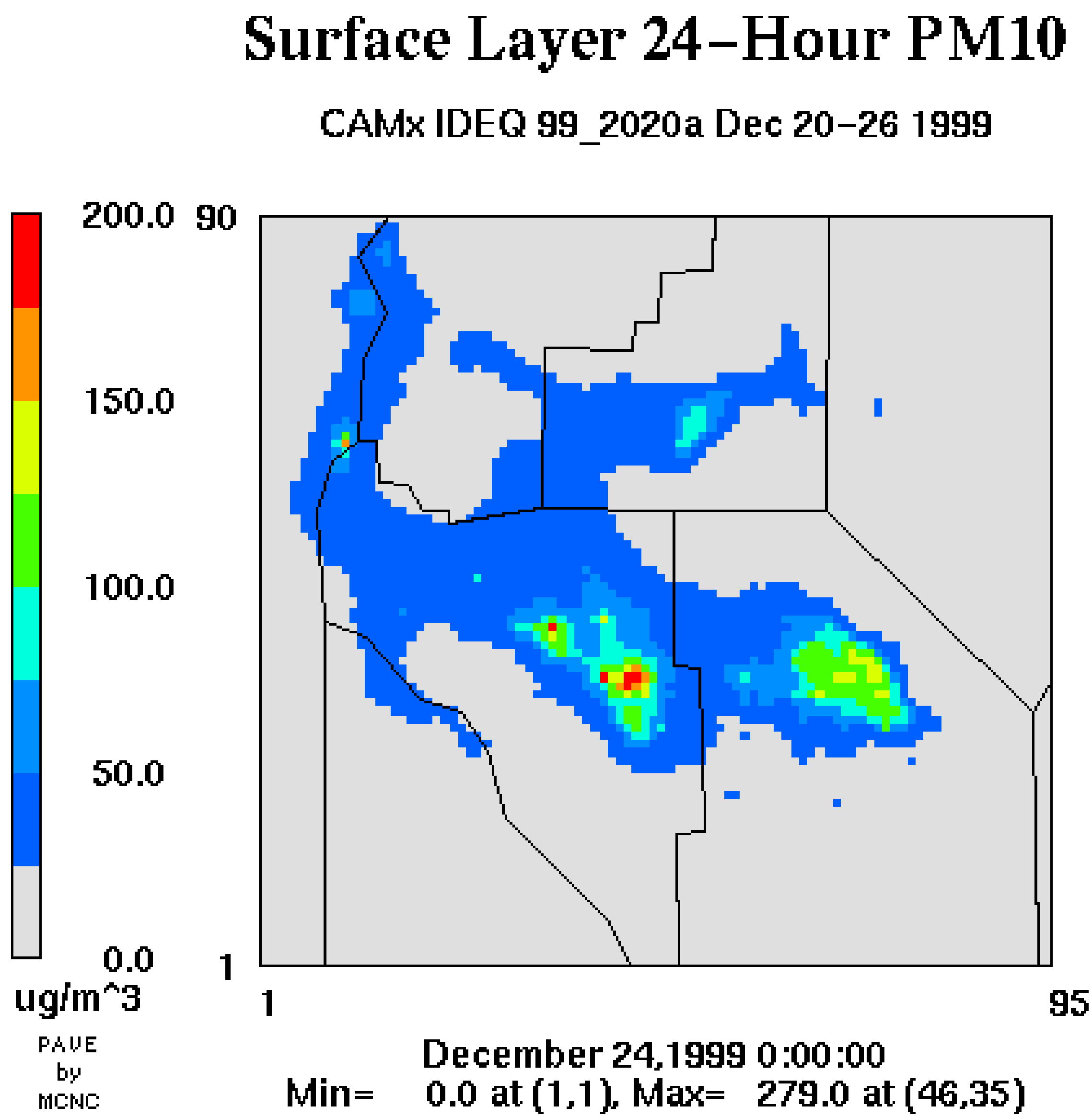


Figure 7-2(c). Spatial distribution of predicted 24-hour PM_{10} on December 24, 1999 for the 2020 future year case.

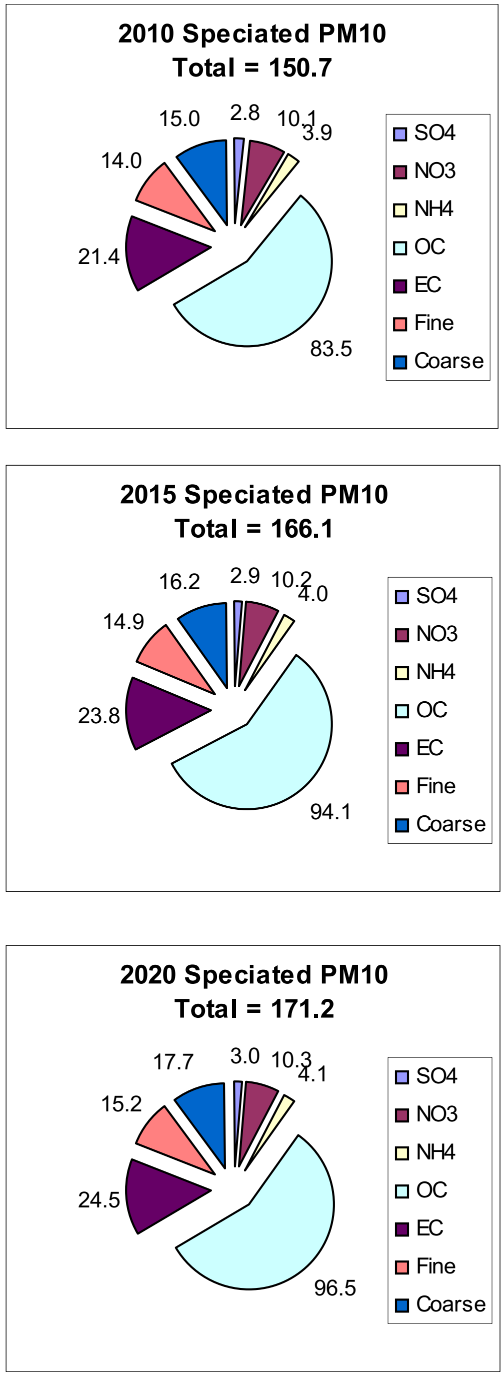


Figure 7-3. Speciated breakdown of total PM_{10} predicted at BFS5 on January 5, 1991 for 2010, 2015, and 2020 in the future year uncontrolled case.

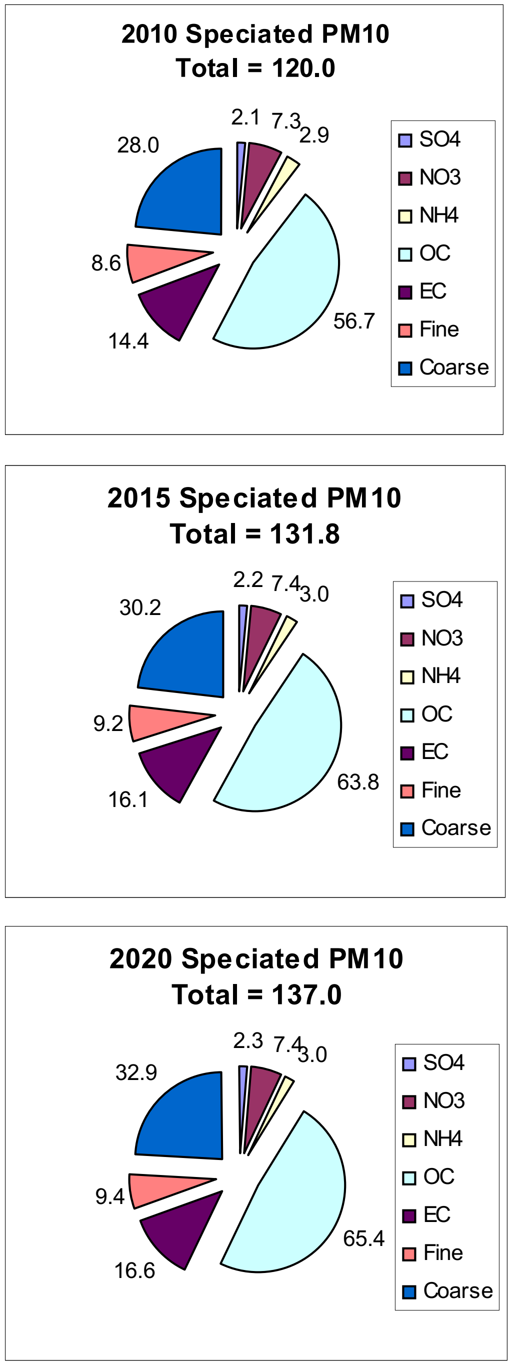


Figure 7-4. Speciated breakdown of total PM_{10} predicted at BFS5 on December 24, 1999 for 2010, 2015, and 2020 in the future year uncontrolled case.

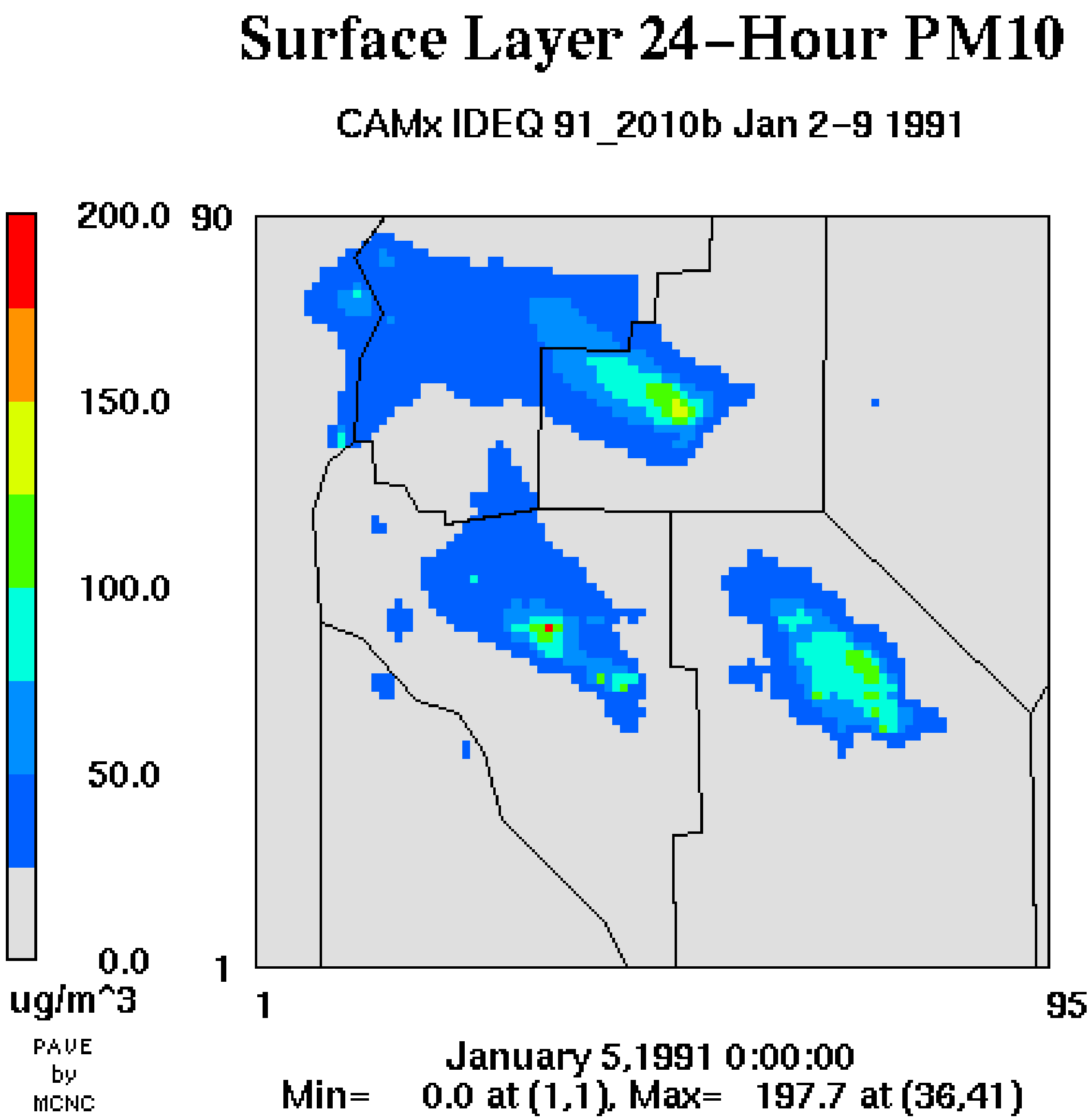


Figure 7-5(a). Spatial distribution of predicted 24-hour PM_{10} on January 5, 1991 for the 2010 future year case with voluntary burn ban.

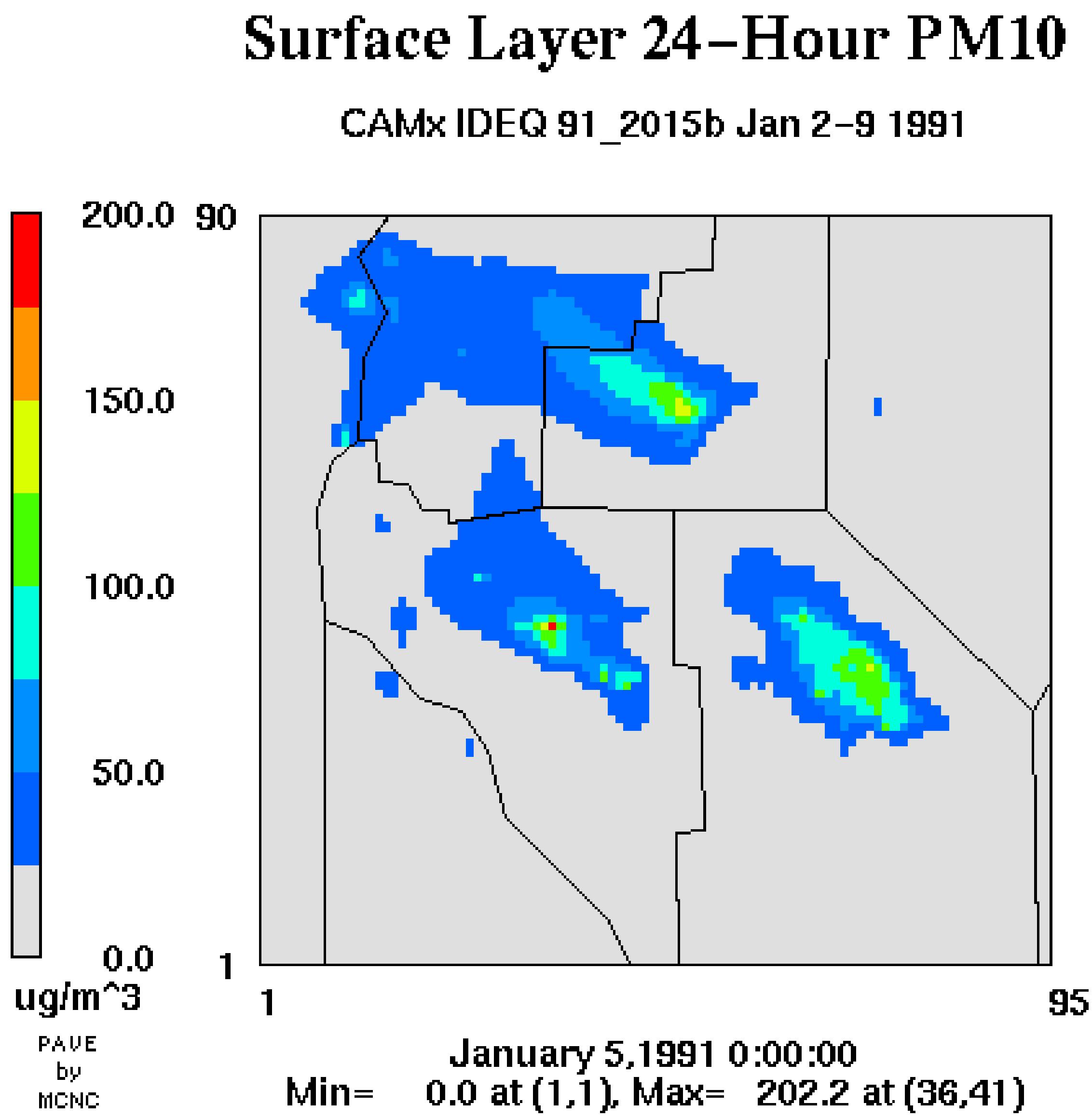


Figure 7-5(b). Spatial distribution of predicted 24-hour PM_{10} on January 5, 1991 for the 2015 future year case with voluntary burn ban.

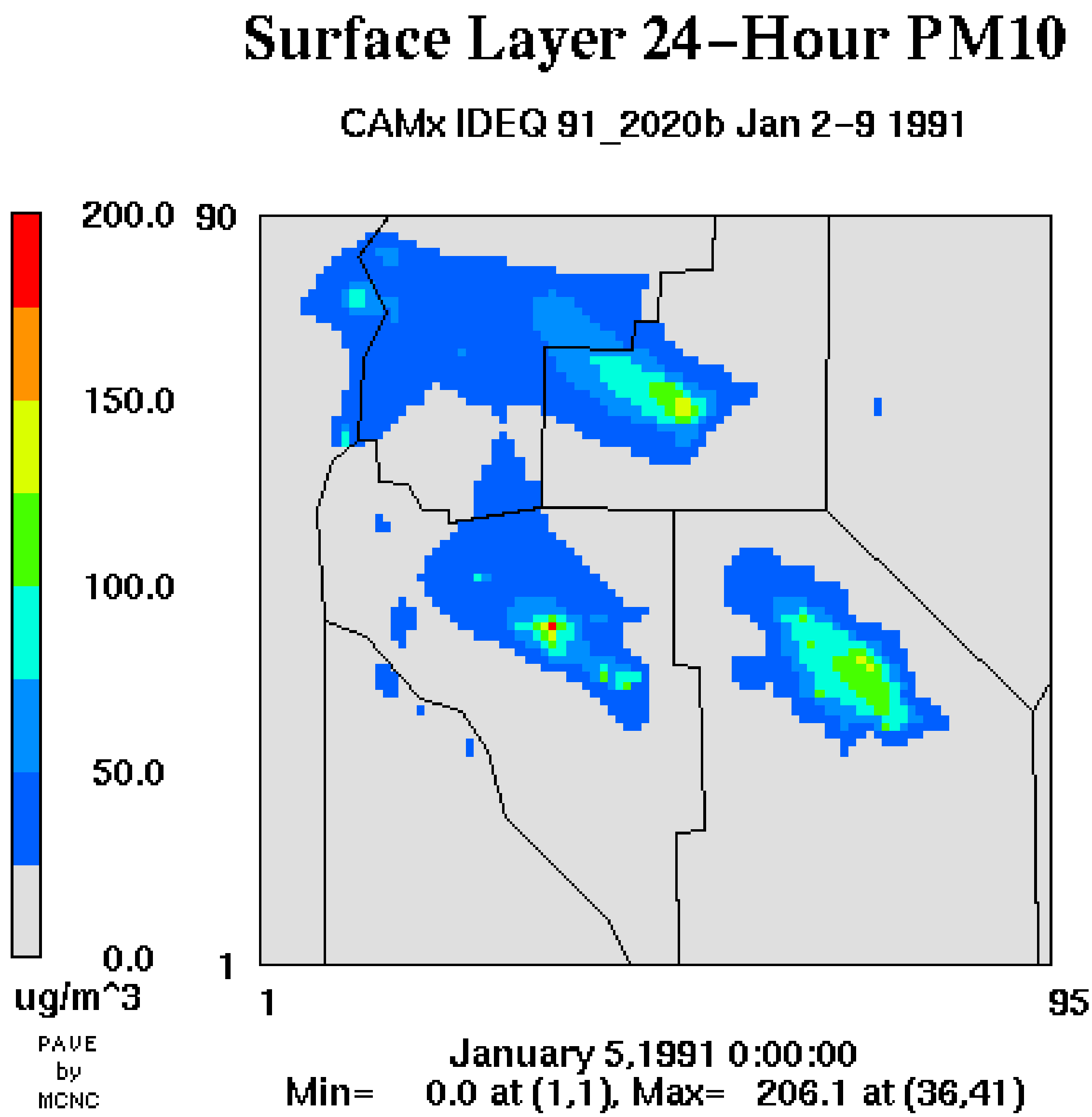
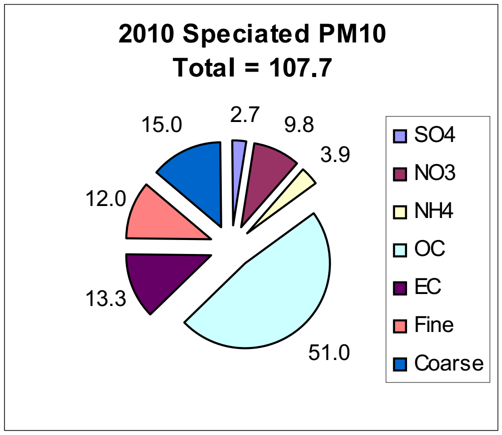
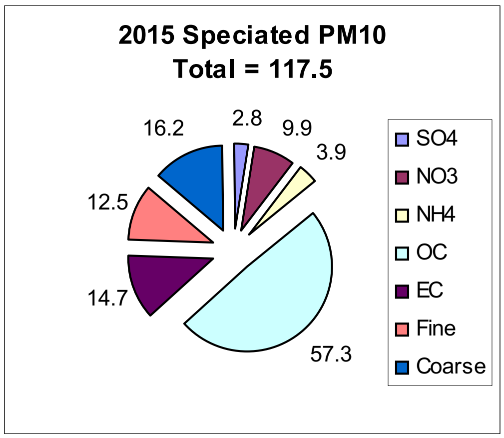


Figure 7-5(c). Spatial distribution of predicted 24-hour PM_{10} on January 5, 1991 for the 2020 future year case with voluntary burn ban.





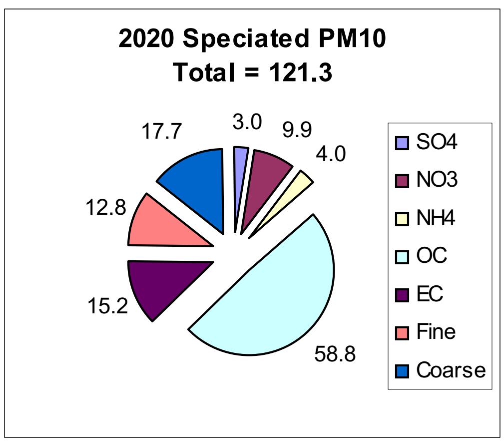


Figure 7-6. Speciated breakdown of total PM_{10} predicted at BFS5 on January 5, 1991 for 2010, 2015, and 2020 in the future year controlled case (voluntary wood burning ban).

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APPENDIX A

Data Acquisition and Preparation for Input to the MM5/CAMx Modeling Systems

This appendix provides a description of several data sets acquired for use in the MM5/CAMx modeling systems for Northern Ada County. The data sets necessary for each component of the modeling system are listed below:

MM5

- Terrain topography at several resolutions appropriate for the various modeling grids to be used;
- Land cover distribution at several resolutions appropriate for the various modeling grids to be used;
- Large-scale meteorological analysis fields for use in defining initial/boundary conditions, as well as for use by the MM5 Four Dimensional Data Assimilation (FDDA) system;
- Regional and local meteorological observation data to enhance the initial/boundary and FDDA fields, and for performance evaluation.

CAMx

- Land cover distribution at a resolution appropriate for the air quality modeling grid;
- Total integrated ozone column data for the calculation of photolysis reaction rate constants;
- Gridded meteorological data at the resolution of the air quality modeling grid (derived from MM5 and described in the supplemental Meteorological Modeling report);
- Gridded and point-specific emission rate data (described in Section 5 and in the Emissions Inventory report);
- Speciated PM and precursor concentration measurements for performance evaluation, and regional data used for specifying episode-specific boundary conditions.

DATA ACQUISITION AND PROCESSING FOR MM5

Terrestrial Input fields

Terrain and land cover databases are available with the MM5 modeling system from the National Center for Atmospheric Research (NCAR), Scientific Computing Division (SCD). The entire system and supporting databases are available via FTP (ftp.ucar.edu); the source code for all system modules, including pre-/post-processors and the core model are contained under the directory “mesouser/MM5V3.” Terrain and land cover databases are provided under “mesouser/MM5V3/DATA.”

MM5 version 3.4 was initially downloaded, along with the supporting databases. Version 3.5 of the modeling system was downloaded subsequent to initial modeling of the December 1999 episode. Modeling of the January 1991 episode was performed with version 3.5 exclusively. The following databases are available:

- Five resolutions of global elevation data: 1-degree, 30-, 10-, 5-, 2-minute, and 30-second;
- Three types of vegetation/land use data:
  - 13-category global coverage with resolutions of: 1-degree, 30-, 10-minute;
  - 17-category North American coverage with resolutions of: 1-degree, 30-, 10-, 5-minute, 30-second;
  - 25-category global coverage with resolutions of: 1-degree, 30-, 10-, 5-, 2-minute, 30-second;
- Two types of land-water mask to define water bodies:
  - 17-category North American coverage with resolutions of: 1-degree, 30-, 10-, 5-minute, 30-second;
  - 25-category global coverage with resolutions of: 1-degree, 30-, 10-, 5-, 2-minute, 30-second.

The MM5 preprocessor TERRAIN is used to define the MM5 grid system to be used for a particular application. For the Boise modeling, the MM5 was run on a grid system comprised of a master domain with coarse grid spacing covering the Pacificnorthwest region (described in more detain in the supplemental Meteorological Modeling report). This grid was used to define the atmospheric conditions on the larger scales in the general region of interest. Higher resolution nested grids were placed within the master grid, telescoping down to the specific area of interest. The nested grids had grid point spacing of 9, 3, and 1 km, respectively. It is the meteorological fields on the finest 1-km grid that were used to drive the air quality model.

The TERRAIN preprocessor is also used to translate the raw terrestrial data at the appropriate resolution to the MM5 grid system. The 25-category global land cover database was selected for the Boise applications. Table A-1 lists the land cover types defined for the 25-category database, along with the default values for soil and vegetation parameters. Note that values are available for two seasons, summer and winter, and that only the winter values are shown in the Table.

The terrain elevation and land cover database resolutions used for each MM5 grid are shown below:

MM5 Grid Resolution	Global Dataset Resolution (Terrain and Land Cover)
27 km	10 minute (~19 km)
9 km	2 minute (~4 km)
3 km	30 second (~925 m)
1 km	30 second (~925 m)

Table A-1. Winter season surface characteristics for each of 25 MM5 landuse types.

Vegetation ID	Vegetation Description	Albedo (%)	Moisture Available (%)	Emissivity (% at 9 µm)	Roughness Length (cm)	Thermal Inertia (cal cm^{-2} K^{-1} s$^{-1/2}$)
1	Urban	18	10	88	50	0.03
2	Dryland Crop/Pasture	23	60	92	5	0.04
3	Irrigated Crop/Pasture	23	50	92	5	0.04
4	Mix Dry/Irrigated Crop/Pasture	23	50	92	5	0.04
5	Crop/Grass Mosaic	23	40	92	5	0.04
6	Crop/Wood Mosaic	20	60	93	20	0.04
7	Grassland	23	30	92	10	0.04
8	Shrubland	25	20	88	10	0.04
9	Mix Shrub/Grass	24	25	90	10	0.04
10	Savanna	20	15	92	15	0.03
11	Deciduous Broadleaf	17	60	93	50	0.05
12	Deciduous Needleleaf	15	60	93	50	0.05
13	Evergreen Broadleaf	12	50	95	50	0.05
14	Evergreen Needleleaf	12	60	95	50	0.05
15	Mixed Forest	14	60	94	50	0.06
16	Water Bodies	8	100	98	0.01	0.06
17	Herb. Wetland	14	75	95	20	0.06
18	Wooden Tundra	14	70	95	40	0.05
19	Barren Sparse Veg.	25	5	85	10	0.02
20	Herbaceous Tundra	60	90	92	10	0.05
21	Wooden Tundra	50	90	93	30	0.05
22	Mixed Tundra	55	90	92	15	0.05
23	Bare Ground Tundra	70	95	95	5	0.05
24	Snow or Ice	70	95	95	5	0.05
25	No data					

Meteorological Analyses

Large-scale three-dimensional meteorological analysis fields are needed by MM5 to specify initial and boundary conditions, and they may also be used by MM5 in its analysis nudging option (a component of the FDDA system). Several large-scale databases are available from NCAR/SCD, and are archived and disseminated by the Data Support Section (DSS). These data are available by contacting SCD/DSS, or by visiting http://dss.ucar.edu/index.html. These data must be ordered from DSS for a small cost to cover data extraction and posting to their FTP site. The analysis datasets include:

- ECMWF/TOGA global surface and upper air analyses, twice daily, 1985-present
- ECMWF global reanalyses, twice daily, 1979-1993
- NCEP global tropospheric analyses, twice daily, 1976-present
- NCEP/NCAR global reanalyses, 6-hourly, 1948-present
- NCEP EDAS North American, 3-hourly, 1996-present

The global analyses are carried on a latitude/longitude grid with 2.5-degree grid point spacing. Therefore, the vast majority of available datasets provide rather crude spatial and temporal resolution. A major improvement is currently being undertaken in a joint effort by NCEP and

NCAR to regenerate the original NCEP global datasets by including new objective analysis methods and incorporating all available data that were historically available. This is referred to as the Reanalysis Project. These data are now available for many historical years at 6-hour intervals. Probably the best dataset in terms of resolution is the EDAS analyses, which stands for the Eta Data Analysis System. Eta is NCEP's current North American mid-range operational forecasting model. The EDAS includes 3-hourly Eta forecasts, run during each 12-hour initialization cycle, blended with many available data sources (including routine observations, radar, wind profilers, aircraft observations, and satellite-derived soundings). These analyses are developed on a North American grid with ~40-km grid point spacing.

For the Boise application, the NCEP EDAS dataset was used for the December 1999 episode. EDAS did not exist in 1991, so the 6-hourly global NCAR/NCEP reanalysis project dataset was procured for the January 1991 episode (considered to be the second best option). The EDAS and Reanalysis Project datasets were mapped to the MM5 grids using the REGRID preprocessor. The products of REGRID include three-dimensional initial condition fields of winds, temperature, pressure, and moisture, and two-dimensional fields of snow cover, surface temperature, and deep-soil temperature. REGRID also provides time-varying boundary conditions for winds, temperature, pressure, and moisture. Finally, three-dimensional fields for these same parameters were used for the analysis nudging component of the MM5 FDDA package.

Regional Meteorological Data

Meteorological data are used by MM5 to enhance the coarse-resolution initial condition and FDDA analysis fields to reflect smaller-scale influences. They are also used to gauge model performance once the simulations are completed.

NCEP global surface and upper air observational data sets were ordered from NCAR for both the January 1991 and December 1999 episodes. Data sets are written in the Office Note 29 format (ON29), which can be read by the MM5 preprocessors to blend into the analysis fields. Upper air data, from data set 353.4, consist of 12-hourly radiosondes and pilot balloon observations. Surface data, from data set 464.0, contains land and ship data at 3-hour intervals. Data was ordered from NCAR via contact with Gregg Walters (baseball@ucar.edu).

Back orders of the January 1991 Daily Weather Maps, Weekly Series, were purchased from NOAA National Data Centers. Weather maps of the 1999 episode were available in the Environ Library and online at http://weather.unisys.com/archive/index.html.

Local Meteorological Data

A veritable dearth of meteorological data exist in southwestern Idaho. In terms of routinely-operated 24-hour ("Class 1") NWS surface airways stations, only one has historically existed in the focus area at the Boise airport. Fortunately, this site also includes an upper air rawinsonde station. The only other nearby Class 1 site is Twin Falls, ID. A few other surface airways stations exists in the region in Pocatello, ID, Elko, NV, Burns OR, and Salt

Lake City, UT. However, the sites outside Boise are too few and remote to have any particular impact on the MM5 simulation in the focus area. Only one meteorological monitoring site is operated by the IDEQ at the Idaho State Fairgrounds meteorological tower, and data were only available for the 1999 episode.

Standard NWS meteorological data were obtained from the Desert Research Institute's Western Regional Climate Center (DRI/WRCC) of the University of Nevada (contact is Dorothy Miller, dmwrcc@dri.edu). A small fee is charged by WRCC for data extraction and posting to their web site. Hourly surface and 12-hourly sounding meteorological data were obtained for the Boise airport for January 1991 and December 1999. The IDEQ provided 15-minute meteorological data from their Fairgrounds site for December 1999. The IDEQ also procured hourly meteorological data from the Caldwell airport, Cloverdale, and the Boise Fire Station for the December 1999 modeling period. No additional data beyond the NWS Boise airport observations were available for 1991. The upper air data were used in the MM5 preprocessor RAWINS to adjust the large-scale analyses prepared by REGRID to account for local influences. The surface data were used to adjust the large-scale analyses at the surface, and for evaluating model performance.

DATA ACQUISITION AND PROCESSING FOR CAMx

Land Cover Data

Land cover distribution inputs to CAMx were generated from the same USGS EROSland cover files used to develop spatial gridding surrogates for the emissions processing. This database provided higher resolution than the MM5 landuse database described above. Specifically, the 450 meter resolution data were mapped to the CAMx input formats using software that ENVIORN possess in-house. CAMx requires the specification of 11 land cover types, so the preprocessing program condensed the raw 21-category data to the coarser CAMx types.

Land use data were obtained from the USGS EROS Data Center web site (http://edcwww.cr.usgs.gov/pub/edcuser/vogel/states) and are a subset of the National Land Cover Dataset (NLCD). This dataset provides dominant land use data for each state at a spatial resolution of 30 meters. The data files for the state of Idaho were downloaded from the site in September 2001. Table A-2 presents the 21 land use categories and codes utilized in the NLCD datasets. More detailed descriptions of the NLCD land use types are available from the USGS web site. These eight bit binary files were imported as a gridded image into ArcInfo, projected to the coordinate system of the modeling grid andresampled at a horizontal resolution of 450 meters. The resampling to a lower resolution was necessary due to inherent limitations in the ArcInfo GIS software. The data was then processed in Arc/Info to create polygon coverages. These coverages were then intersected first with state and county boundary files and then with the appropriate modeling grid coverage. The resulting coverages contain attributes specifying the fractional land area of each land use type within each county and modeling grid cell. These data were then exported for use as gridding surrogates in the

Table A-2. Land use categories and codes utilized in the NLCD.

NLCD Category Code	NLCD Category Description	In-House Category Code
11	Open Water	1
12	Perennial Ice/Snow	2
21	Low Intensity Residential	3
22	High Intensity Residential	4
23	Commercial/Industrial/Transportation	5
31	Bare Rock/Sand/Clay	6
32	Quarries/Strip Mines/Gravel Pits	7
33	Transitional	8
41	Deciduous Forest	9
42	Evergreen Forest	10
43	Mixed Forest	11
51	Shrubland	12
61	Orchards/Vineyards/Other	13
71	Grasslands/Herbaceous	14
81	Pasture/Hay	15
82	Row Crops	16
83	Small Grains	17
84	Fallow	18
85	Urban/Recreational Grasses	19
91	Woody Wetlands	20
92	Emergent Herbaceous Wetlands	21

emissions modeling with EPS2. After export, the land use codes were assigned to those recognized by EPS2, and separately assigned to those recognized by CAMx.

Ozone Column Data

CAMx requires daily two-dimensional maps of total vertically integrated ozone column density in order to calculate important photolysis reaction rate constants (most notably NO_2) through the use of a complex radiative transfer model. The ozone column data are freely available at a NASA web site (http://jwocky.gsfc.nasa.gov), which provides measurements from Total Ozone Mapping Spectrometer (TOMS) instrumentation aboard three different satellite platforms since 1978. The data are provided daily and globally at 1.25 by 1.00 degree resolution. TOMS data were downloaded for 1-9 January, 1991, and for 20-26 December, 1999.

ENVIRON possesses preprocessing software for CAMx that maps the TOMS ozone column data to the air quality modeling grid. Once processed, these data are used in a 2-stream radiative transfer model developed at NCAR to calculate various photolysis reaction rates by solar zenith angle, altitude, ozone column, haze turbidity, and surface UV albedo (which is based on the gridded landuse distribution). The photolysis rates from the radiative transfer model are provided directly to CAMx. The effects of clouds on photolysis rates are treated within CAMx since clouds comprise part of the meteorological input fields.

PM and Precursor Concentration Data

Speciated and total PM_{10} concentrations are used for evaluating the performance of the air quality model in replicating conditions in the base year, and for developing estimates of boundary conditions. Since only the December 1999 episode was modeled to establish baseline performance, only local data for this period were actually needed. However, all available data for the January 1991 episode were also procured, particularly to ascertain the potential differences in defining boundary conditions for future year scenarios using 1991 conditions.

A few years ago, the DRI conducted a speciated linear rollback analysis of several historical Ada County episodes. The resulting database contains speciated PM_{10} measurements from sites operated by the IDEQ, including elemental data from episodes from 1988 through 1997 (including 1991). We obtained this particular dataset in Excel spreadsheet format.

We also obtained the latest DRI PM database, which includes elemental (speciated) PM filter measurements from IDEQ sites for episodes between 1986 and 2000, including the Treasure Valley Fine Particulate Study. This database also includes data extracted from surrounding IMPROVE sites for these periods. The data were obtained from Hampden Kuhns via FTP in a Access database format.

ENVIRON separately obtained ambient PM data during the 1991 and 1999 modeled episodes from the IMPROVE monitoring network. IMPROVE monitoring sites collect $PM_{2.5}$ samples on Teflon, nylon and quartz filters for total mass (gravimetric) analysis as well as speciation analyses for elements, ions, and organic and elemental carbon. PM_{10} samples are collected on a separate Teflon filter at some sites for determining PM_{10} total mass. Data for sites in Idaho and northern Nevada for December, 1990 - January, 1991 and December, 1999 – January 2000 were downloaded from the IMPROVE web site (http://vista.cira.colostate.edu/improve). Each 24-hour integrated sample consisted of total mass and speciation analysis results on one or more filter media. Sampling intervals varied from one in three to one in six days. Details of the IMPROVE sampling and analysis methodology are available at http://vista.cira.colostate.edu/improve/Publications/publications.htm.

Several parameters of significance to the modeling analysis were derived from the raw data. These include an estimate of the total soil mass in each sample based on the elemental analysis (SOIL), organic matter estimated from hydrogen (OMH), organic matter estimated from carbon (OMC), ammonium nitrate estimated from the nitrate ion concentration (NH4_NO3), and ammonium sulfate estimated from the sulfate ion concentration (NH4)2_SO4. In most cases, the sulfate ion concentration itself is estimated from the elemental sulfur concentration rather than from the ion chromatography analysis of the nylon filter sample. Formulas used to calculate these derived quantities and assumptions used to derive these formulas are described by http://vista.cira.colostate.edu/improve/Publications/OtherDocs/IMPROVEDataGuide/IMPROVEDataGuide.htm.

Data werer extracted from the latest DRI PM dataset for the 20-26 December 1999 modeling period. Elemental information was aggregated up to bulk species consistent with the individual species modeled by CAMx, following the methodology used for the IMPROVE dataset described above. Species included ammonium, nitrate, sulfate, organic mass, elemental carbon, remaining fine mass (crustal components and metals), and coarse mass. These aggregated concentration were then formatted for use in the CAMx statistical evaluation post processor. IMPROVE data were analyzed to select boundary conditions for CAMx (described in Section 5).

APPENDIX B

Why Road Dust Concentrations Are Over-estimated in Eulerian Grid Models

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March 20, 2002

Summary

Eulerian grid models generally over-predict coarse particle (2.5 ~ 10 μm) concentrations. This analysis indicates that the models may over-predict concentrations by a factor of 1.7 to 11 (2 to 13 for Treasure Valley CAMx modeling) due primary to artificially re-mixing the particles in the lowest modeling layer at each time step, setting the first layer too high, and ignoring the mass loss between the time steps.

1. Introduction

It is well known by model users that Eulerian grid dispersion models generally overestimate road dust concentrations[1]. Compared to monitoring data and receptor modeling analyses, grid modeling often overestimates the road dust contribution to the ambient concentration by a factor of four or more. Investigations indicate that the over-prediction is due to systematic errors rather than random errors. It is unlikely caused by errors in emission factors, VMT data, or the dispersion mechanics, however, treatment of deposition processes may be the problem. It is assumed in most grid dispersion modeling that the particulate matter is distributed uniformly in the lowest modeling layer, which is usually 20 meters or higher. However, measurements and modeling indicate that the road dust only reaches an elevation of a few meters above the ground. The particles are not uniformly distributed in the layer, but concentrated in lower part of the layer. The coarse particles are removed near the source by gravitational force and impaction in a relatively short time[2]. This is true both for paved and unpaved roads[1]. Figure 1 (Countess, 2001) shows this phenomenon.

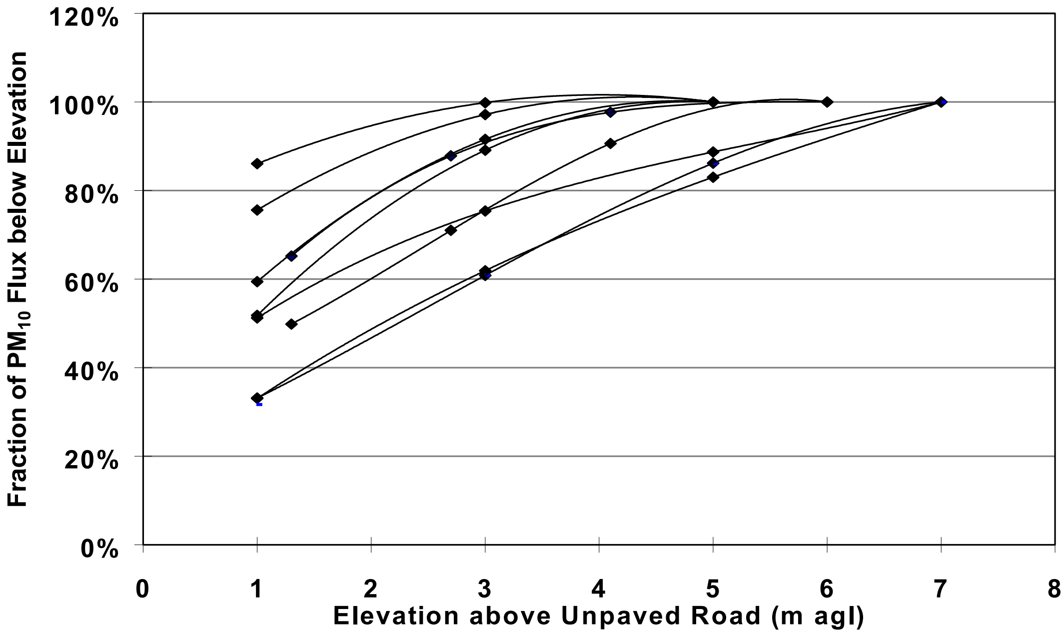


Figure 1. Cumulative horizontal PM_{10} flux at different downwind elevations above different unpaved roads (data from Cowherd, 1999; plot from Watson et. al., 2000)

Because the coarse particles fall out in a much shorter time than the models assume, the mass deposition between the time steps is significant, this loss is ignored by the models. These assumptions are critical for the modeling predictions. The next sections will demonstrate how this process affects the modeling results.

2. Mixing and Non-Mixing Process

2.1. Deposition Velocity and Deposition Rate

Deposition velocity is an important parameter in air quality dispersion modeling of particulates. The deposition rate of coarse particles (percentage of the total suspended mass deposited in a time step) is not only a function of deposition velocity, but it also varies with the layer thickness, size distribution, the vertical profile of the suspended particles, and length of modeling time step. These important factors are often ignored in dispersion modeling.

Many studies have shown that the coarse particles from roadways remain in a shallow layer above the ground. Figure 1 indicates that on average more than 70% of the particles are suspended below 2 meters. Many other studies show the initial thickness of the road dust layer to be about 2 to 3 meters. In most modeling practice, the lowest layer is assumed to be about 20 meters. Since the deposition velocity is assumed to be a constant, the assumption of a 20-meter modeling layer significantly reduces the deposition rate by a factor of H_m/H_r, because

$$R_d = V_d/H \tag{1}$$

where V_d is the deposition velocity, which is a constant for a monodisperse aerosol, H is the layer height, H_m the model defined height, H_r the real road dust layer height, assuming the particles are uniformly mixed in the layer. The deposition velocity remains constant throughout the process, but the deposition rate may depend on mass spatial distribution and other factors. We will use the initial deposition rate R_{d0} (the deposition rate in the first time step) derived from equation (1) to show the effect of re-mixing at each time step.

2.2. Mixing and Non-Mixing Processes

a) Single Pulse Emission

Eulerian grid models assume the particles are uniformly re-mixed at each time step. In such a process, the mass in the cell (emissions at the first time step only) at a time step *n* is:

T_0 $\quad M_0 = E$

T_1 $\quad M_1 = E(1 - R_{d0})$

T_2 $\quad M_2 = E(1 - R_{d0})^2$

.

..

T_n $\quad M_n = E(1 - R_{d0})^n$ (with mixing, emissions at the first time step only) (2)

where R_{d0} is the initial deposition rate at the time step zero.

On the other hand, if the particles are uniformly mixed in the cell only at the initial time step, and are not re-mixed at the consecutive time steps, the particles will continue to fall, and the deposition rate will be significantly higher than the deposition rate in the case with mixing. In this process, the mass remaining in the cell at the time step *n* will be:

T_n $\quad M_n = E(1 - nR_{d0})$ (without mixing, emissions at the first time step only) (3)

These two processes are plotted in Figure 2 for deposition rates of 1%, 5%, and 10%. The graph indicates that the particles stay in the air much longer when re-mixed at each time step than those without mixing. We can predict that the longer the particles stay in the air, the higher the concentrations will be.

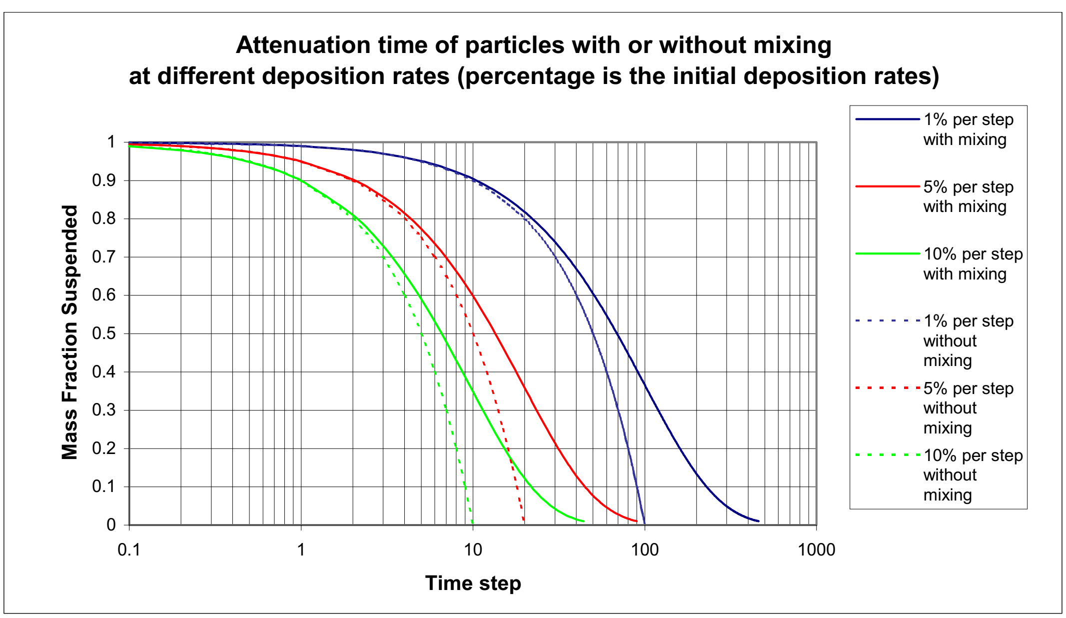


Figure 2. Attenuation process of particles with and without mixing (no new emissions except the first time step). It takes about 4.5 times longer for particles with mixing to completely phase out than without mixing.

b) Continuous Emission

When emitted particles continuously enter into the cell, the concentration is building up, and mass deposition will increase with the increasing concentration until equilibrium is reached. Following are the calculations for the mass remaining in the cell at the time step *n* for scenarios with and without mixing, respectively. To demonstrate the effect of mixing at each time step, mono-disperse aerosols with constant deposition velocity is assumed. However, the same equations apply for each particle size independently.

With Mixing

In the scenario with mixing, at the time step T_0, T_1, T_2……T_n, the mass $\boldsymbol{M_n}$ is:

T_0 $\quad M_0$
T_1 $\quad M_0 \cdot (1- R_{d0}) + E$
T_2 $\quad [M_0 \cdot (1- R_{d0}) + E](1- R_{d0}) + E$
….

where $\boldsymbol{R_{d0}}$ is the initial mass deposition rate, in terms of percent of the total mass. If the deposition velocity is a constant, $\boldsymbol{R_d = R_{d0}}$ is also a constant in a well-mixed cell. By reorganizing the terms, we get:

T_0 $\quad M_0$
T_1 $\quad M_0 (1- R_{d0}) + E$
T_2 $\quad M_0 (1- R_{d0})^2 + E(1- R_{d0}) + E$
.
.
.
T_n $\quad M_0 (1- R_{d0})^n + E (1- R_{d0})^{n-1} + E (1- R_{d0})^{n-2} + …….+ E (1- R_{d0}) + E$

A general form for the mass at $\boldsymbol{T_n}$ is:

$$M_n = M_0(1- R_{d0})^n + E \sum_{k=0}^{n-1} (1- R_{d0})^k \tag{4}$$

Since $\boldsymbol{(1-R_d) < 1}$, the first term vanishes when $\boldsymbol{n \to \infty}$. As $\boldsymbol{R_d}$ is a constant, the second term converges when $\boldsymbol{n \to \infty}$, which is the total mass in the cell at an equilibrium state.

$$M_{n \to \infty} = E / R_{d0} \qquad \text{(with mixing)} \tag{5}$$

Without Mixing

In the scenario without mixing, the total mass in the cell is:

T_0 $\quad M_0$
T_1 $\quad M_0(1- R_{d0}) + E$
T_2 $\quad M_0(1- 2R_{d0}) + E(1- R_{d0}) + E$
T_3 $\quad M_0(1- 3R_{d0}) + E(1-2 R_{d0}) + E(1- R_{d0}) + E$
.
.
.
T_n $\quad M_0(1- nR_{d0})+E(1-(n-1)R_{d0}) + E(1- (n-2)R_{d0}) + …….+ E(1- R_{d0})+E \qquad (6)$

When $n = 1/R_{d0}$, $M_0\ (1- nR_{d0}) = 0$, the equilibrium state is reached, and the total mass in the cell will be:

$$M_n\ (n \geq 1/R_{d0}) = E\ (1/R_{d0} + 1)/2 \qquad \text{(without mixing)} \qquad (7)$$

Keep in mind that the deposition rate is no longer a constant in the process without mixing, and R_{d0} is the initial deposition rate, which is the same value in a continually re-mixed cell.

2.3. Correction Factor Due to the Mixing Process

An Excel spreadsheet was used to plot the model equation 6. When $n \geq 1/R_{d0}$, the mass in the cell will remain constant as long as the emission and deposition rate remain constant. It takes much less time for this process to reach the equilibrium than the scenario with mixing (equation (4)). Figure 3 shows these two processes with an initial deposition rate of 5% in the first time step.

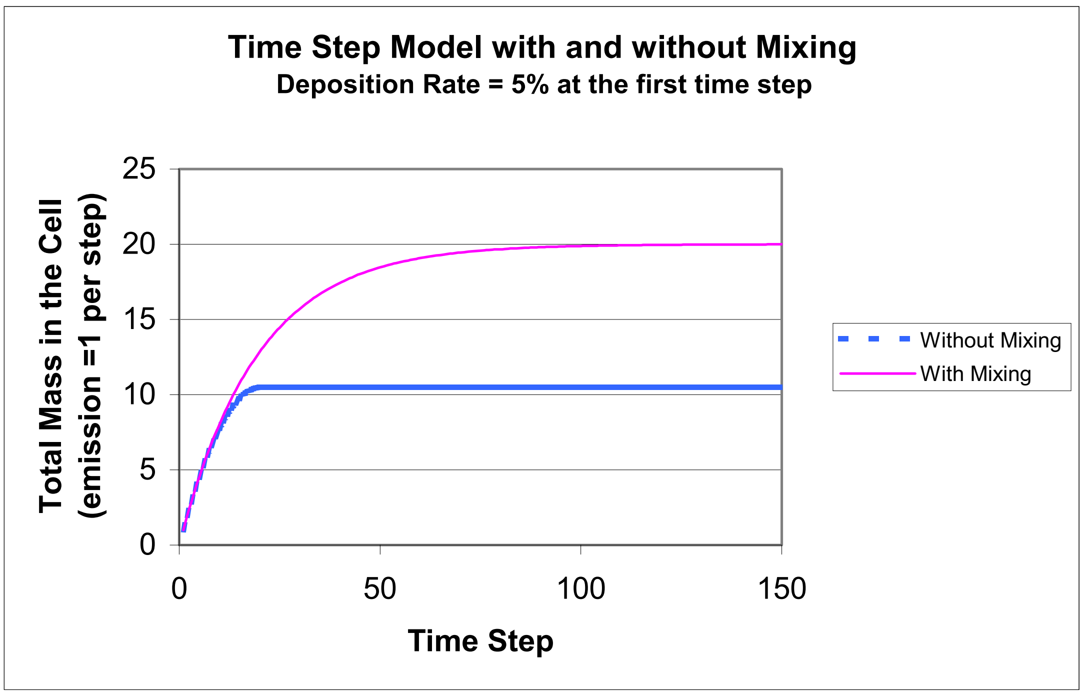
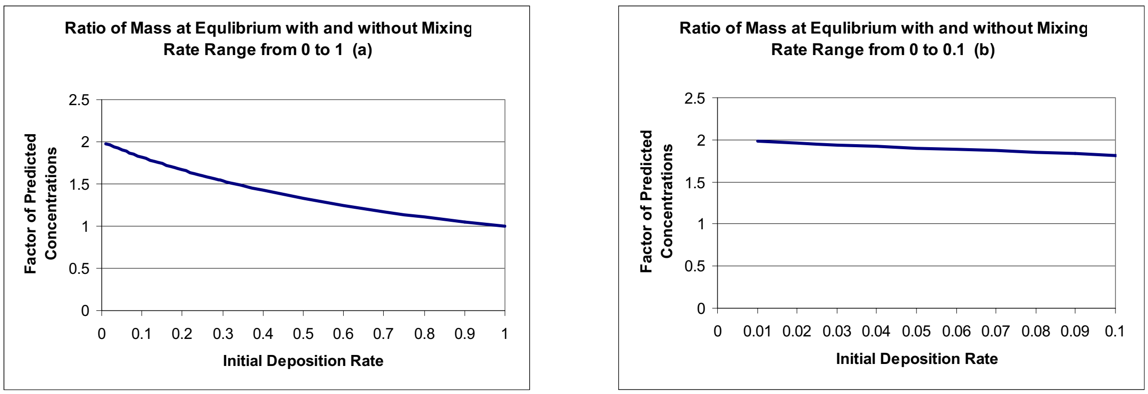


Figure 3. Mass continues to accumulate in the cell in the scenario with mixing, while mass reaches an equilibrium state much earlier in the scenario without mixing. The total mass at the equilibrium in the cell with mixing is about two times greater than in the cell without mixing. The factor is insensitive to the deposition rate when deposition rates are small (Figure 4).

Mass continues to accumulate in the cell until time step #100 in the scenario with mixing, while equilibrium state is reached much earlier in the scenario without mixing. The total mass in the cell with mixing is about two times greater than in the cell without mixing. The time to reach the equilibrium state for the scenario with mixing takes about 4.5 times longer than the scenario without mixing, which can be also seen in Figure 2. The ratio of mass in the cell with mixing divided by the mass in the cell without mixing is independent of the deposition rate and time step length (as long as the time step is reasonably short compared to the cycle time).

Figure 4 indicates that the ratio of correction factor at equilibrium is in a range from one to two, and it is about two for small deposition rates, appropriate for PM_0 under stagnation conditions.



(a) $0 < R_{d0} < 1$ (b) $0 < R_{d0} < 0.1$

Figure 4. Correction factor as a function of deposition rate. The correction factor is insensitive to rate at small rates. The deposition rate in air quality dispersion modeling is usually less than 5% per time step.

In most grid dispersion models, it is assumed that particles are uniformly mixed throughout the layer at all times. However, in the reality, falling particles are usually not mixed in the original layer, especially under stable conditions. Particles continue to fall without being redistributed throughout the height. Therefore, we expect to see higher concentration in the lower portion of the layer, and thus a higher deposition rate.

To compare the results of non-mixing scenario with measured data, the vertical distribution predicted by non-mixing model is plotted on top of Figure 1 and presented in Figure 5. The distribution predicted from the model fits the lowest curve in Figure 5. The higher percentage of particle flux found in the lower portion of the layer in the measured data probably represents a natural PM_{10} mixture while the model is a single size model.

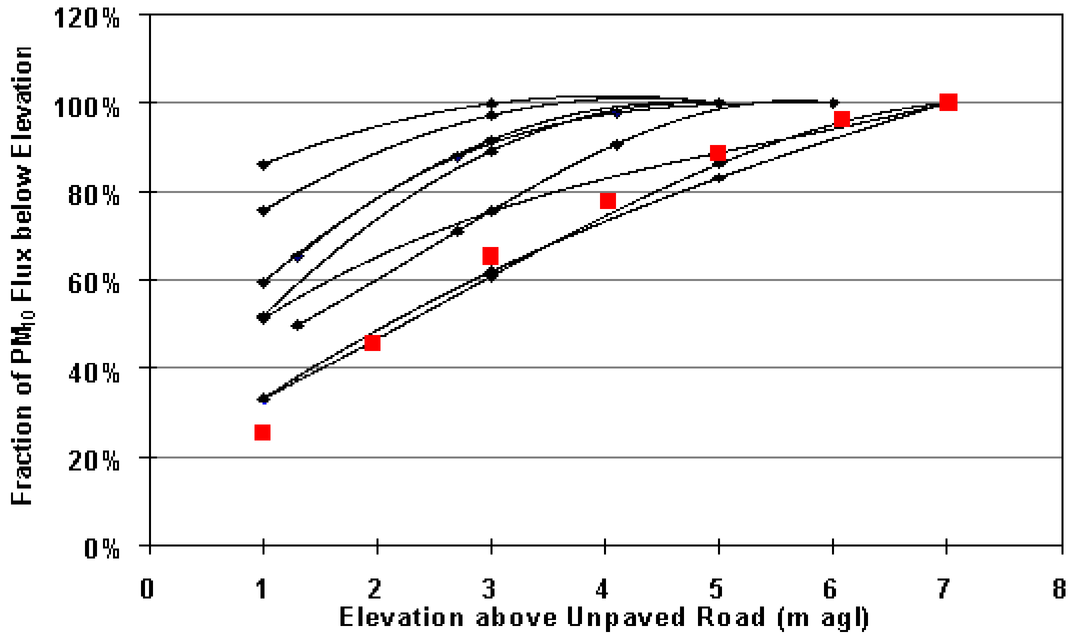


Figure 5. Comparison of modeled and measured vertical profile of particle distribution. The square dots are the modeled data (non-mixing) and the other curves are measured data(see Figure 1).

In conclusion, grid models over-predict coarse particle concentrations by a factor up to 2 due to artificially re-mixing the particles at all time steps. This is a systematic error in the modeling for a stagnation condition.

3. Effect of Height of First Layer in the Modeling

3.*1. Scenario with gravitational sedimentation only*

Although the deposition rate is significantly reduced by artificially increasing the layer height, we will show that the modeled concentrations are not affected by this artificial height change in the scenario in which only gravitational sedimentation occurs.

Since R_{d0} is small ($R_{d0} < 0.05$ per time step in modeling practice), $1/R_{d0} >> 1$, and equation (7) can be rewritten in the form:

$$M_n \cong E\ /2R_{d0} \quad \text{(without mixing, small } R_{d0}\text{)} \qquad (8)$$

Equations (5) and (8) indicate that the mass in the cell is a simple function of the initial deposition rate. Substitute R_{d0} with V_d using equation (1),

$$M_n \cong EH/2V_d \quad \text{(without mixing)} \qquad (9)$$
$$M_n = EH/V_d \quad \text{(with mixing)} \qquad (10)$$

The equation (9) and (10) indicate that the predicted total mass in the cell is proportional to the defined cell height both in the mixing and non-mixing models. The concentration in these two scenarios will be:

$$C(\text{without re-mixing}) = M_n / HA \cong E/2AV_d \quad (11)$$
$$C(\text{with re-mixing}) = M_n / HA = E/AV_d \quad (12)$$

where A is the grid cell area. We can see that in both cases, the models over-predict the total mass in the cell, the total mass is proportional to the height. However, the final concentrations are independent of the height, it is a function of deposition velocity only. We have assumed here that the only deposition is due to the gravitational sedimentation. In the next section, we use a dispersion model to examine the scenario when other deposition mechanisms come to play.

3.2. Height effect in the WYNDvalley Modeling

When the mass is concentrated in a shallow layer, deposition due toimpaction and turbulence will significantly increase, as well as the dispersion rate at the upper boundary of the layer. The dispersion model WYNDvalley is used to examine this hypothesis. WYNDvalley is a simplified grid model with simple meteorological inputs that couldexercised with varying cell heights. It was exercised with actual emission data (January, 1995, Treasure Valley, Idaho). All the conditions were held constant except the height of the layers, which ranged from 2 to 25 meters. The average concentrations predicted by WYNDvalley are approximately the same (36.7 to 38.6μg/m^3) for the modeled layer height ranging from 10 to 25 meters. However, when the cell height is reduced to match the road dust source elevation of 2 to 5 meters, the predicted concentrations ranged 16 to 30 μg/m^3. A low wind speed of 0.5m/s was used throughout the simulation time. The model over-predicts the PM_{10} concentration by a factor of 1.3 to 2.4 for heights of 5m to 2m, respectively. The results are shown in Figure 6.

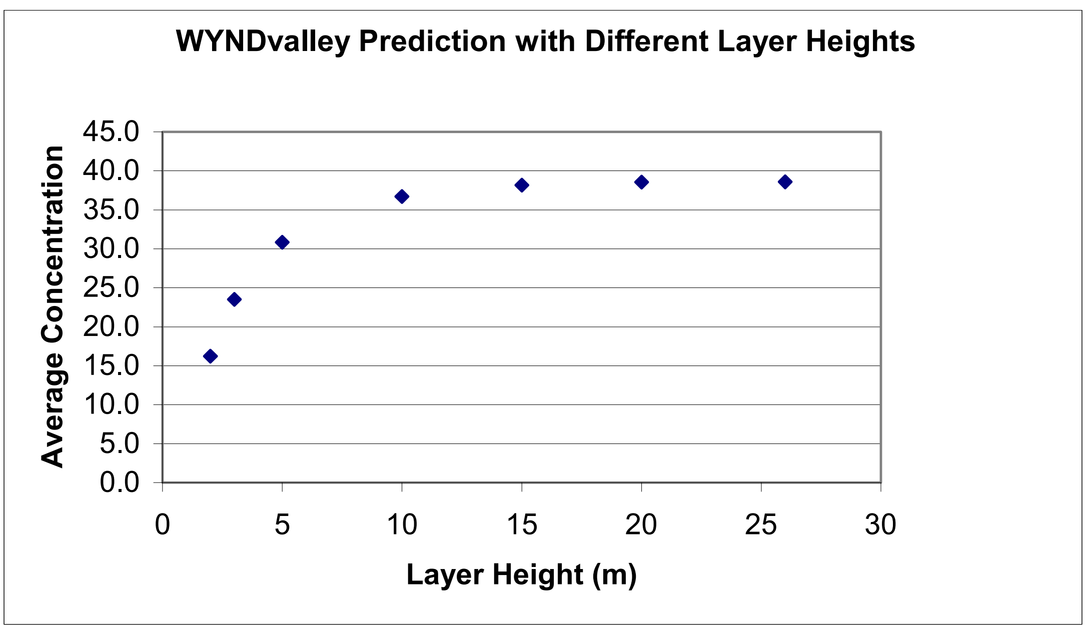


Figure 6. Model predicted concentration is a function of defined layer height.

In addition, the artificially defined higher layer not only changes the deposition rate of mass in the cell, but also changes the spatial distribution of the mass. The smaller deposition rate results because the artificially defined higher first layer (usually 10 or more times higher) causes particles to artificially suspend longer, as indicated in Figure 2. Even with a low wind speed of 1.0 m/s in a stable condition, the coarse particles may travel several kilometers further than they actually do, and fine particles will travel much further due the much longer suspension time. This causes the over-prediction of coarse particles in the local scale modeling, and errors in the regional modeling where transportation of fine particles is more important.

3. The Attenuation Between Time Steps

Grid dispersion models simulate fresh emissions every time step. A sum of the emission during the time step is used, however, the mass loss during the time is not counted. Since the road dust layer is only two to seven meters high, and most particles are concentrated within the lower first meter (Figure 1), the mass loss is significant during a time step such as 30 seconds. The DRI one dimensional deposition model predicts about 30% of the mass will be lost during a 30 second time step, and other studies measured even much greater loss rates[3]. Figure 7 shows that about 90% of the mass is lost within 50 meter from the source. The data in Figure 7 are not adjusted for wind speeds and this probably is one of the reasons why the data are so scattered. Using the average values in the Figure, and assuming wind speed is 0.5 m/s, 1m/s or 1.5m/s, we can calculate the correction factor is 1.3, 1.9 and 2.3 respectively. This estimate is for a time step of 30 seconds, when a time step length used in the modeling is different, the factor needs to be adjusted accordingly.

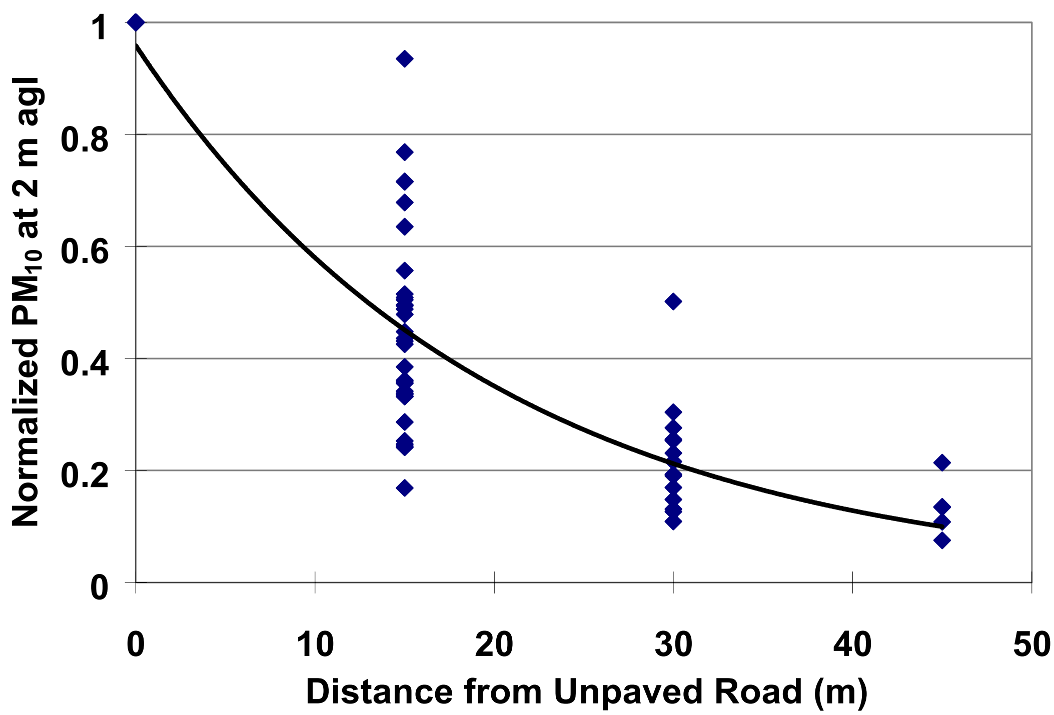


Figure 7. Attenuation of PM_{10} concentrations with distance from an unpaved road (Watson et al., 1996)

5. Other Factors

The above simple analysis is offered to help to understand the major causes inthe road dust over-prediction modeling problem. However, it cannot be used to find the exact factor for an individual modeling project because the factors vary with the situation, and since many other processes were not considered. Turbulence over rough surfaces may increase the deposition rate, or on the other hand, it may mix the particles in the cell and make the deposition rate lower. In urban areas, buildings and vehicle traffic makes the situation in the lower layer more complicated (Kaarim. et. Al., 1998; Karstnwer-Klein, et al., 1999). All these factors will affect the modeling results. However, the deposition rate is probably a single most important parameter in this problem.

6. Conclusion

The above analysis indicates that the traditional grid models could over-estimate road dust concentrations by a factor ranging from 1.7 to 11 due to the treatments of mixing, layer height, and time step in the modeling, which all affect the deposition processes. All three factors are caused by systematic errors in the modeling which tend over-predict coarse particle concentrations. The range of the factor is large due the uncertainties of the conditions; however, it should be in the middle range in most cases. The factor is higher (2 to13) for Treasure Valley CAMx modeling, because the emission factor used in the emission estimate was provided by DRI road study, which is approximately 1.2 times higher than AP-42 estimate. The ranges of these effects and other possible factors are summarized in Table 1.

Table 1. Factors affecting the prediction of road dust concentrations

Source of Errors	**Correction Factor Range**
Artificial mixing particles in the cell at all time steps[a]	×1 ~ 2
Setting the first layer higher than the dust source height	×1.3 ~ 2.4
Ignoring the mass loss setting out between the time steps	×1.3 ~ 2.3
Tracker vs. AP-42 Factor[b]	~1.2
Total effect of above	×2 ~ 13
Other Possible Factors	**Possible Effect**
Emission factor errors	±
Impaction on low terrain and obstructions	+
Some form of precipitation model does not count (e.g. frozen fog)	+
Sampling uncertainty	±
Moisture content	+

a. This is the theoretical range. Factor is usually close to two, especially for stagnation conditions. Factors near one only occur for complete mixing which is rare (e.g., wind blown dust)

b. This factor is due to the difference between the emission factor used by Boise Regional Office based on the DRI Tracker data and AP-42. It is not applicable for other cases.

In conclusion, a difference between measured and modeled road dust concentrations by a factor of up to 11 is explained. In view of these results, it may be most appropriate to reconcile the model predicted road dust concentrations using other data such as receptor modeling results and rollback modeling results before the proper corrections are made for the models. Since all these factors are related to the deposition rate, it is recommended that the deposition velocity in the modeling be modified instead of modifying the emission rates, in this way the mass horizontal distribution will be simulated more accurately.

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Appendix C

Development of the
Northern Ada County
PM_{10} Maintenance Plan

Supplemental Report for Part 4:

Meteorological Modeling For The
PM_{10} Maintenance SIP

DEVELOPMENT OF THE NORTHERN ADA COUNTY PM_{10} MAINTENANCE PLAN

Supplemental Report for Part 4:

METEOROLOGICAL MODELING FOR THE PM_{10} MAINTENANCE SIP

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1. INTRODUCTION

The Idaho Department of Environmental Quality is required to submit a PM_{10} Maintenance Plan for Northern Ada County to the U.S. Environmental Protection Agency by September 30, 2002. The maintenance plan must show that over the next ten years the region continues to meet the episodic (24-hour) and annual PM_{10} National Ambient Air Quality Standards set forth in the Clean Air Act Amendments of 1990. The forecast of PM_{10} air quality into the future is achieved through computer modeling.

This report provides supplementary technical documentation describing the development and analysis of meteorological input fields for the Treasure Valley PM_{10} dispersion modeling database. The dispersion modeling has been performed to evaluate projected episodic PM_{10} air quality in several future years. The meteorological and air quality modeling approaches follow from the Dispersion Modeling Protocol (ENVIRON, 2001), which was developed in the initial stages of this study. A modeling protocol is needed whenever dispersion modeling is carried out to support the development of a State Implementation or Maintenance Plan. The requirements for a modeling protocol are described in two U.S. Environmental Protection Agency (EPA) documents (EPA, 1991; EPA, 2001).

The companion Dispersion Modeling report (Emery et al., 2002) provides a description of the Treasure Valley geography, a conceptual model (characterization) of the historical episodic PM_{10} problem in the region, a history of the regulatory status of northern Ada County, and the rationale for episode selection. The study objectives and overview of approach are reiterated here for completeness.

1.1 PURPOSE AND OBJECTIVES OF THE CURRENT STUDY

The primary objective of this project is to develop a PM_{10} Maintenance Plan for Northern Ada County, to be completed and submitted to EPA by September 30, 2002. The development of this plan is based upon new modeling and data analyses, including: (1) the development of a new PM_{10} emissions inventory for the 1999 base year, and for the future years of 2010, 2015, and 2020; (2) new receptor modeling using data from the January 1991 exceedance episode and the winter 1999-2000 field study; (3) new episodic dispersion modeling with a photochemical grid model that includes improved wintertime meteorological characterization of the Treasure Valley and non-linear secondary aerosol formation; and (4) new speciated linear rollback calculations to evaluate annual PM_{10} levels in the three future years.

This supplemental report describes results from a subset of the activities of (3) above. Specifically, it provides a technical summary of the meteorological modeling system, configuration, and approach for developing time- and space-resolved meteorological fields for two historical PM_{10} episodes in the Treasure Valley. Companion reports provide information on emissions inventory development, episodic air quality dispersion modeling, annual speciated rollback modeling, and receptor modeling.

1.1.1 Overview of Approach

The dispersion model selected for this study was CAMx (ENVIRON, 2002), an Eulerian (gridded) photochemical model with a reduced-form aerosol chemistry algorithm. The modeling grid domain was configured to cover the focus area of Ada and Canyon Counties, and surrounding environs, with 1 km grid cell size. The vertical depth of the domain extended from the surface to about 1500 m. CAMx was supplied with hourly three-dimensional gridded meteorological fields (winds, temperature, pressure, moisture, clouds) generated from the MM5 meteorological model (Dudhia, 1993). CAMx was first applied to a December 1999 PM episode using episode-specific emissions and meteorology to establish and demonstrate acceptable model performance in replicating 24-hour PM_{10} levels. Then the model was used to estimate 24-hour PM_{10} levels in three future years by simulating the worst case meteorological conditions of the January 1991 exceedance episode in combination with future year episodic emission inventories. The dispersion modeling approach and results are fully described in the Dispersion Modeling report (Emery et al., 2002).

The annual PM_{10} standard has never been exceeded in Northern Ada County and it appears that annual-average concentrations will continue to remain well below the standard in the immediate future. However, both 24-hour and annual standards must be addressed in modeling for Maintenance Plans, especially given the long-range projections to 2020. Therefore, the annual modeling component was addressed using the speciated linear rollback technique. This approach utilized the results of receptor modeling conducted by DRI (1998), in combination with future year projected county-level emissions inventories. Annual modeling is described in a separate supplementary report.

2. METEOROLOGICAL MODELING APPROACH

Today's state-of-the-science PM models require more complex meteorological inputs thanhave been needed in past modeling of the Treasure Valley. Usinghigh resolution terrain-following vertical coordinates, these models require time-resolved and fully three-dimensional gridded fields of winds, temperatures, moisture and vertical mixing rates. Such fields can only be developed using a meteorological model; unfortunately the lack of meteorological data in Ada County presented a significant limitation to the use of many model types. The approach to simulate PM_{10} in the Treasure Valley, developed in the initial stages of this study, required meteorological modeling for two specific historical PM_{10} episodes in December 1999 and January 1991 to produce hourly input meteorology for the air quality model.

2.1 MODEL SELECTION

Three possible meteorological modeling approaches were considered in the initial stages of this study (ENVIRON, 2001):

1) Use of a diagnostic model, such as CALMET, to model the Treasure Valley at 1-km grid spacing (diagnostic models interpolate observations to the grid, and possess parameterizations to address the influences of terrain-driven flow);

2) Use of a prognostic model, such as MM5, in concert with a diagnostic model to supply the latter with regional coarsely-spaced data as pseudo-observations (prognostic or "forecasting" models can provide accurate large-scale fields of winds, temperature, and moisture to augment local observations); and

3) Use of a prognostic model alone to model the Treasure Valley at 1-km grid spacing (such models can be applied with "nested" grids, where a large regional grid with coarse resolution can "telescope" down to a small area of interest with very fine resolution).

CALMET and MM5 are currently the most widelyused, publicly available, diagnostic and prognostic (respectively) meteorological models for air quality modeling applications. These models are well documented, are endorsed in the draft guidance for fine PM demonstrations (EPA, 2001), and have been used separately and in tandem for numerous applications across the country, including ozone and PM SIPs, PSD analyses, and EIS/EIR support.

The options listed above were ordered to indicate a progressive increase in complexity, which usually translates to increased accuracy, and certainly to increased data volume, processing requirements, necessary user expertise, and computer/project resources. Initially, the simplest (first) approach was proposed, whereby the CALMET model would rely on the available local meteorological data in the Treasure Valley and provide three-dimensional fields of winds, temperatures, humidity, and mixing height to CAMx. However, CALMET alone was the least attractive alternative as it cannot provide mass consistent wind and thermodynamic fields, which is important when applying the latest air quality modeling platforms. As fancy observation "interpolators", the ability of diagnostic models such as CALMET to generate realistic and representative meteorological inputs depends entirely on the size, coverage, and completeness of the local measurement network. It became clear that the first approach would not be feasible given the particularly limited measurement dataset available during the 1991 episode (a single site at the Boise airport).

The second approach provided an attractive alternative that would drastically improve CALMET accuracy by better defining regional meteorology, but for a relatively modest incremental cost. Also, the use of MM5 output as input to CALMET would guide the CALMET results to be more mass consistent. The third approach would be significantly more costly due to heavy computational and data demands, but was viewed as superior to the first two. The IDEQ and EPA promoted the second approach, the MM5-CALMET "hybrid", for use in this project since it was technically superior to the first option and adequately balanced technical rigor with costs and schedule. However, further discussions with the study's Technical Review Committee resulted in the final consensus that the best approach for episodic modeling (which is the critical demonstration in this case) was to undertake the third approach.

Specifically, three-dimensional gridded hourly meteorological fields of winds, temperature, humidity, clouds, and mixing height, were developed using the MM5 for both historical episodes examined in this study. The MM5 was applied with multiple nested grids down to the fine resolution used for the air quality modeling with observational data nudging to help faithfully reflect locally measured conditions. These fields were processed for input to the CAMx model to define the environmental conditions that affect ambient chemistry, transport, diffusion, and removal. The MM5 simulated the entire spectrum of atmospheric dynamics and structure from synoptic scales to the very local scales to be resolved by the CAMx 1-km grid. A summary of the formulation of this model is provided next, along with additional information on the configuration of available options and the input data.

2.2 DESCRIPTION OF MM5

The Fifth Generation Mesoscale Model (MM5) is one of the most technically advanced and widely used public-domain prognostic meteorological models. The model is described by Dudhia (1993). MM5 has been widely used for preparing inputs to urban- and regional-scale photochemical air quality models for over ten years, including RADM, UAM-V, REMSAD, CAMx, SAQM, DAQM, and MAQSIP. EPA has incorporated MM5 into the Models-3/CMAQ air quality modeling system, and EPA-derived MM5 data fields are being used by the Western Regional Air Partnership (WRAP) in their regional haze modeling with Models-3/CMAQ and REMSAD. MM5 has also been, and is currently being used, in almost every major regulatory modeling study throughout the U.S.

MM5 was developed at Pennsylvania State University over 20 years ago, and in cooperation with the National Center for Atmospheric Research (NCAR), has consistently been improved and updated over the last 10 years. MM5 is based on a set of non-hydrostatic primitive equations for momentum, heat, moisture, and continuity. Optional parameterizations exist for boundary layer turbulence (mixing) schemes, cloud and precipitation physics, solar and terrestrial radiative transfer through the atmosphere, land-surface heat/moisture budget models, and sub-grid scale moist convection. MM5 can also encompass a broad range of scales, from the fine mesoscale (~1 km) to synoptic systems (~1000 km). One- or two-way interactive grid nesting is allowed, as well as moveable nests that allow the model to follow weather features such as hurricanes. MM5 also contains a Four Dimensional Data Assimilation (FDDA) package that allows the simulation to be "nudged" toward pre-existing gridded analysis fields or individual point observations separately or in combination.

The model's horizontal grid arranges the wind variables to be staggered from thermodynamic and state variables for numerical stability and to optimize efficiency of the solution. A number of map projections are available. The Lambert Conformal projection is used for air quality applications in the U.S. The vertical coordinate is a terrain-following normalized pressure depth (sigma-p) representation. Typically, 20 to 30 vertical levels are specified, with the first grid point 20 to 50 meters above the surface, and the top of the model around 16-km above sea level (above the tropopause).

2.3 MODELING APPROACH

This study employed the latest versions of MM5 (versions 3.4 and 3.5). The model was used to simulate multi-scale meteorological patterns centered over the southwestern Idaho area for the December 20-26, 1999 and January 2-9, 1991 episodes. To properly simulate the larger-scale influences on meteorology in the Treasure Valley, the MM5 was applied on a system of telescoping nested grids in the horizontal. The smallest grid was defined to cover the CAMx modeling domain at the same 1-km horizontal resolution, while the largest grid covered the western U.S with much larger grid spacing. Meteorological results are greatly enhanced if a significant portion of the synoptic scale is included in the simulation domain, rather than just forced in through the boundary conditions or the four-dimensional data assimilation scheme. This is now the common approach taken in almost every major air quality study in the country.

MM5 is capable of simulating meteorology on all grids together in a single run (a process referred to as two-way grid nesting), or separately in individual runs (referred to as one-way nesting). The two-way process allows large-scale features on a regional grid to influence smaller-scale conditions on progressively smaller higher-resolution grids, and for any local effects to feedback to the larger scale, all in a single model run. Only thedown-scale (large to small) cascade of information is treated in the one-way process in successive runs for each grid. Four nested grids were utilized for episodic MM5 modeling in this project. The largest grids covered the western U.S. with resolution ranging from27 km grid spacing in the December 1999 application, to 81 km grid spacing in the January 1991 application. The use of different horizontal grid structures for each episode was prompted by the different resolutions of the large-scale analyses used for supplying initial/boundary conditions and for analysis nudging. The specific horizontal grid configurations for each episode are more fully described in the following Sections.

As a prognostic model, the MM5 must be run over the depth of the entire troposphere (~16-km depth) so that large scale three-dimensional dynamics of the atmosphere are properly simulated. This is particularly important so that MM5 can simulate the stagnation under deep vertical subsidence that occur during PM episodes. The MM5 vertical layer structure was defined to provide adequate resolution in the lower troposphere for the purposes of air quality modeling, and added several additional layers to the top of the troposphere. The MM5 and

CAMx vertical layer structures used in this study are provided in Figure 2-1. All nested grids for both episodes were configured with this single vertical structure.

k	sigma	pressure	height	thickness	CAMx Layers
26	0.0000	100.00	15675.96	2004.22	
25	0.0500	145.00	13671.75	1584.98	
24	0.1000	190.00	12086.77	1321.62	
23	0.1500	235.00	10765.15	1139.09	
22	0.2000	280.00	9626.06	1004.34	
21	0.2500	325.00	8621.72	900.35	
20	0.3000	370.00	7721.37	817.43	
19	0.3500	415.00	6903.94	749.61	
18	0.4000	460.00	6154.33	693.00	
17	0.4500	505.00	5461.32	644.98	
16	0.5000	550.00	4816.34	603.67	
15	0.5500	595.00	4212.67	567.73	
14	0.6000	640.00	3644.94	536.15	
13	0.6500	685.00	3108.79	508.15	
12	0.7000	730.00	2600.64	483.15	
11	0.7500	775.00	2117.49	460.68	
10	0.8000	820.00	**1656.81**	440.36	--10---
9	0.8500	865.00	**1216.45**	338.91	---9---
8	0.8900	901.00	**877.55**	246.93	---8---
7	0.9200	928.00	**630.62**	161.35	---7---
6	0.9400	946.00	**469.27**	158.83	---6---
5	0.9600	964.00	**310.44**	117.52	---5---
4	0.9750	977.50	**192.92**	93.05	---4---
3	0.9870	988.30	**99.87**	53.89	---3---
2	0.9940	994.60	**45.97**	23.27	---2---
1	0.9970	997.30	**22.70**	22.70	---1---
0	1.0000	1000.00	**0.00**	=================Surface======	

Figure 2-1. The MM5 vertical grid structure based on 26 terrain-following normalized pressure (sigma-p) levels, including the surface. Heights (m) given in the figure are relative to sea level according to a standard atmosphere; pressure is inmillibars. Heights in each grid column scale by the underlying terrain pressure altitude. The right side of the figure indicates the levels mapped to the CAMx modeling domain (heights shown in bold).

The application of MM5 is a complicated exercise that is governed by its own protocol (ENVIRON, 2001). It should be understood that the application of a complex model like this is not undertaken using a prescriptive, pre-determined approach. It is usually necessary to refine the selection of some model options and physics configurations during the application to improve model performance.

We have operated the MM5 utilizing its FDDA capabilities. As a predictive (or forecasting) model, the MM5 is subject to a growing amount of error over the course of an extended simulation due to uncertainties in initial/boundary conditions, limits in spatial and temporal resolution, and simplifications in the governing equations. In simulations of historical episodes (as opposed to actual forecasting), FDDA is used to "nudge" model predictions toward observational analyses and/or discrete measurements to control model "drift" from conditions that actually occurred. This approach has consistently been shown to provide powerful advantages in running predictive mesoscale models for multi-day episodes, and has become a standard for air quality applications.

For this project, we have supplied the FDDA system with large-scale gridded meteorological analyses derived from the Eta Data Assimilation System (EDAS), and the NCEP/NCAR Reanalysis Project (NNRP). These same datasets were used to provide initial and boundary conditions for the MM5 simulations. Beginning in 1996, the EDAS provides 3-hourly gridded meteorological fields developed from the initialization cycle runs of the National Weather Service's (NWS) Eta operational forecast model, which ingest observations from a combination of several systems (routine measurements from surface and upper air sites, radar networks, and satellite profilers). The EDAS domain covers most of the North American continent on a Lambert Conformal grid with 40-km grid spacing, and extends vertically from the surface to 50 mb (~20-km) with more than 20 pressure levels of data. The EDAS dataset was used in modeling the December 1999 episode. With the relatively high resolution afforded with EDAS, the coarsest regional MM5 grid for this episode was set to cover the northwest U.S. at a horizontal grid spacing of 27 km.

The NNRP dataset is global in coverage with much the same data as EDAS, but on a much coarser 2.5-degree latitude/longitude grid and at a coarser time resolution of 6 hours. The analyses are derived purely from observational data (i.e., not mixed with operational predictive model output as in EDAS). The parameters of wind, temperature, and humidity are analyzed on 20 pressure levels from 1000 mb to 10 mb. The NNRP analyses extend back to the 1940's, and thus were available for use in modeling the January 1991 episode. This coarser dataset prompted the need for a larger MM5 regional domain that covered much of western North America at 81 km grid spacing. The EDAS and NNRP datasets are further described below.

Other MM5 data input requirements include topographic and land use information prepared for each simulation grid. Standard MM5 preprocessor programs were used with terrain databases available from NCAR to develop these inputs (see below).

The MM5 provides a wealth of options to configure the model for various parameterizations and physics packages. We configured the model using the most appropriate options for the particular grid resolutions and for the meteorological conditions existing in the area of concern. Initial MM5 runs were made for each episode that invoked the FDDA capabilities of the model, and that were configured with the physical treatments and options that have worked best in past photochemical modeling exercises. Subsequent runs were made in which various physics options, parameterizations, and nudging methodologies were altered to improve the performance in replicating observations in the Treasure Valley. The MM5 configurations for each episode are described in the following sections.

MM5 output for the 1991 and 1999 episodes were compared against meteorological analyses and local observations. This was carried out both graphically and statistically to evaluate model performance for winds, temperatures, boundary layer heights, and the placement, intensity, and evolution of key weather phenomena. Currently, there is little or no guidance/ protocol on the evaluation of meteorological output for the purposes of regulatory air quality modeling. ENVIRON has recently developed a statistical evaluation and analysis program that automates the comparison between MM5 output and observational data. The products of this program include tables of daily statistics, including bias, error, and "agreement parameters" that have been developed over the years by various developers and users of meteorological models. The program also plots time-series of hourly observations, predictions, and error statistics so that the diurnal performance of MM5 may be assessed. Given the limited amount of available meteorological measurement data in the Treasure Valley, the bulk of the performance evaluation relied on the analysis of maps of surface and aloft wind and temperature distributions to ensure that the modeled conditions were plausible in areas well removed from observational sites.

2.4 DATA ACQUISITION AND PROCESSING FOR MM5

2.4.1 Terrestrial Input fields

Terrain and land cover databases are available with the MM5 modeling system from the National Center for Atmospheric Research (NCAR), Scientific Computing Division (SCD). The entire system and supporting databases are available via FTP (ftp.ucar.edu); the source code for all system modules, including pre-/post-processors and the core model are contained under the directory "mesouser/MM5V3." Terrain and land cover databases are provided under "mesouser/MM5V3/DATA."

MM5 version 3.4 (and later 3.5) was downloaded, along with the supporting databases. The following databases are available:

- Five resolutions of global elevation data: 1-degree, 30-, 10-, 5-, 2-minute, and 30-second;
- Three types of vegetation/land use data:
  - 13-category global coverage with resolutions of: 1-degree, 30-, 10-minute;
  - 17-category North American coverage with resolutions of: 1-degree, 30-, 10-, 5-minute, 30-second;
  - 25-category global coverage with resolutions of: 1-degree, 30-, 10-, 5-, 2-minute, 30-second;
- Two types of land-water mask to define water bodies:
  - 17-category North American coverage with resolutions of: 1-degree, 30-, 10-, 5-minute, 30-second;
  - 25-category global coverage with resolutions of: 1-degree, 30-, 10-, 5-, 2-minute, 30-second.

The MM5 preprocessor TERRAIN is used to define the MM5 grid system to be used for a particular application. The TERRAIN preprocessor is also used to translate the raw terrestrial data at the appropriate resolution to the MM5 grid system. The 25-category global land cover database was selected for the Boise applications. Table 2-1 lists the land cover types defined for the 25-category database, along with the default values for soil and vegetation parameters.

Table 2-1. Winter season surface characteristics for each of 25 MM5 landuse types.

Vegetation ID	Vegetation Description	Albedo (%)	Moisture Available (%)	Emissivity (% at 9 μm)	Roughness Length (cm)	Thermal Inertia (cal cm^{-2} K^{-1} $s^{-1/2}$)
1	Urban	18	10	88	50	0.03
2	Dryland Crop/Pasture	23	60	92	5	0.04
3	Irrigated Crop/Pasture	23	50	92	5	0.04
4	Mix Dry/Irrigated Crop/Pasture	23	50	92	5	0.04
5	Crop/Grass Mosaic	23	40	92	5	0.04
6	Crop/Wood Mosaic	20	60	93	20	0.04
7	Grassland	23	30	92	10	0.04
8	Shrubland	25	20	88	10	0.04
9	Mix Shrub/Grass	24	25	90	10	0.04
10	Savanna	20	15	92	15	0.03
11	Deciduous Broadleaf	17	60	93	50	0.05
12	Deciduous Needleleaf	15	60	93	50	0.05
13	Evergreen Broadleaf	12	50	95	50	0.05
14	Evergreen Needleleaf	12	60	95	50	0.05
15	Mixed Forest	14	60	94	50	0.06
16	Water Bodies	8	100	98	0.01	0.06
17	Herb. Wetland	14	75	95	20	0.06
18	Wooden Tundra	14	70	95	40	0.05
19	Barren Sparse Veg.	25	5	85	10	0.02
20	Herbaceous Tundra	60	90	92	10	0.05
21	Wooden Tundra	50	90	93	30	0.05
22	Mixed Tundra	55	90	92	15	0.05
23	Bare Ground Tundra	70	95	95	5	0.05
24	Snow or Ice	70	95	95	5	0.05
25	No data					

Note that values are available for two seasons, summer and winter, and that only the winter values are shown in the table. The terrain elevation and land cover database resolutions used for each MM5 grid are shown below:

MM5 Grid Resolution	Global Dataset Resolution (Terrain and Land Cover)
27 km	10 minute (~19 km)
9 km	2 minute (~4 km)
3 km	30 second (~925 m)
1 km	30 second (~925 m)

2.4.2 Meteorological Analyses

Large-scale three-dimensional meteorological analysis fields are needed by MM5 to specify initial and boundary conditions, and they may also be used by MM5 in its analysis nudging option (a component of the FDDA system). Several large-scale databases are available from NCAR/SCD, and are archived and disseminated by the Data Support Section (DSS). These data are available by contacting SCD/DSS, or by visiting http://dss.ucar.edu/index.html.

These data must be ordered from DSS for a small cost to cover data extraction and posting to their FTP site. The analysis datasets include:

- ECMWF/TOGA global surface and upper air analyses, twice daily, 1985-present
- ECMWF global reanalyses, twice daily, 1979-1993
- NCEP global tropospheric analyses, twice daily, 1976-present
- NCEP/NCAR global reanalyses, 6-hourly, 1948-present
- NCEP EDAS North American, 3-hourly, 1996-present

The global analyses are carried on a latitude/longitude grid with 2.5-degree grid point spacing. Therefore, the vast majority of available datasets provide rather crude spatial and temporal resolution. A major improvement is currently being undertaken in a joint effort by NCEP and NCAR to regenerate the original NCEP global datasets by including new objective analysis methods and incorporating all available data that were historically available. This is referred to as the Reanalysis Project. These data are now available for many historical years at 6-hour intervals. Probably the best dataset in terms of resolution is the EDAS analyses, which stands for the Eta Data Analysis System. Eta is NCEP's current North American mid-range operational forecasting model. The EDAS includes 3-hourly Eta forecasts, run during each 12-hour initialization cycle, blended with many available data sources (including routine observations, radar, wind profilers, aircraft observations, and satellite-derived soundings). These analyses are developed on a North American grid with ~40-km grid point spacing.

For the Boise application, the NCEP EDAS dataset was used for the December 1999 episode. EDAS did not exist in 1991, so the 6-hourly global NCAR/NCEP reanalysis project dataset was procured for the January 1991 episode (considered to be the second best option). The EDAS and Reanalysis Project datasets were mapped to the MM5 nested grids using the REGRID preprocessor. The products of REGRID include three-dimensional initial condition fields of winds, temperature, pressure, and moisture, and two-dimensional fields of snow cover, surface temperature, and deep-soil temperature. REGRID also provides time-varying boundary conditions for winds, temperature, pressure, and moisture. Finally, three-dimensional fields for these same parameters were used for the analysis nudging component of the MM5 FDDA package.

2.4.3 Regional Meteorological Data

Meteorological data are used by MM5 to enhance the coarse-resolution initial condition and FDDA analysis fields to reflect smaller-scale influences. They are also used to gauge model performance once the simulations are completed.

NCEP global surface and upper air observational data sets were ordered from NCAR for both the January 1991 and December 1999 episodes. Data sets are written in the Office Note 29 format (ON29), which can be read by the MM5 preprocessors to blend into the analysis fields. Upper air data, from data set 353.4, consist of 12-hourly radiosondes and pilot balloon observations. Surface data, from data set 464.0, contains land and ship data at 3-hour intervals. Data was ordered from NCAR via contact with Gregg Walters (baseball@ucar.edu).

Back orders of the January 1991 Daily Weather Maps, Weekly Series, were purchased from NOAA National Data Centers. Weather maps of the 1999 episode were available in the Environ Library and online at http://weather.unisys.com/archive/index.html.

2.4.4 Local Meteorological Data

A veritable dearth of meteorological data exist in southwestern Idaho. In terms of routinely-operated 24-hour ("Class 1") NWS surface airways stations, only one has historically existed in the focus area at the Boise airport. Fortunately, this site also includes an upper air rawinsonde station. The only other nearby Class 1 site is Twin Falls, ID. A few other surface airways stations exist in the region in Pocatello, ID, Elko, NV, Burns OR, and Salt Lake City, UT. However, the sites outside Boise are too few and remote to have any particular impact on the MM5 simulation in the focus area. Only one meteorological monitoring site is operated by the IDEQ at the Idaho State Fairgrounds meteorological tower, and data were only available for the 1999 episode.

Standard NWS meteorological data were obtained from the Desert Research Institute's Western Regional Climate Center (DRI/WRCC) of the University of Nevada (contact is Dorothy Miller, dmwrcc@dri.edu). A small fee is charged by WRCC for data extraction and posting to their web site. Hourly surface and 12-hourly sounding meteorological data were obtained for the Boise airport for January 1991 and December 1999. The IDEQ provided 15-minute meteorological data from their Fairgrounds site for December 1999. The IDEQ also procured hourly meteorological data from the Caldwell airport, Cloverdale, and the Boise Fire Station for the December 1999 modeling period. No additional data beyond the NWS Boise airport observations were available for 1991. The upper air data were used in the MM5 preprocessor RAWINS to adjust the large-scale analyses prepared by REGRID to account for local influences. The surface data were used to adjust the large-scale analyses at the surface, and for evaluating model performance.

3. MODELING THE JANUARY 1991 EPISODE

3.1 GENERAL OVERVIEW

The latest version of MM5 (version 3.5) was employed to simulate the atmospheric conditions during the last Treasure Valley PM_{10} exceedance episode of January 1991. Data from the global NNRP analyses and NCEP surface and upper air observations were processed to provided the model with initial and boundary conditions. The initial model simulation (hereafter referred as “Run 1”) was configured with simple ice microphysics, the Grell cumulus parameterization, the high-resolution Blackadar boundary layer scheme, and a simple slab soil model. Results from this run showed that the diurnal variation of surface layer temperature and humidity (at ~10 meters) was weak and that the model greatly overestimated the temperature and humidity throughout the period.

Numerous experimental simulations were conducted to improve the model performance. A more sophisticated land surface model, the Oregon State University Land-Surface Model (OSU LSM), was used as a substitute for the simple slab model. This also required that the MRF boundary layer scheme be chosen over the Blackadar approach as the latter is not coupled with the OSU LSM. The model results were improved with this change, and the model reasonably reproduced the amplitude of the observed diurnal variation in surface temperature and humidity. It was found that FDDA was a key factor in simulating this episode successfully. A multi-scale data assimilation technique, including surface and three-dimensional analysis and observational nudging, was configured to produce highly reliable simulations of the wind, temperature, and moisture. Sensitivity tests of different nudging coefficients were undertaken; it was determined that model results were improved by increasing the nudging strengths, especially for temperature and humidity. The observational nudging of surface wind helped to improve the model results for surface wind speed. By increasing the FDDA nudging coefficients and employing the observational nudging of surface winds in “Run 11”, the overestimation of temperature and mixing ratio was reduced and the model results displayed much closer agreement with observations as compared to Run 1. Better agreement with the Boise airport observations is assumed to lead to improved characterization of meteorology throughout the basin.

3.2 DOMAIN CONFIGURATION

The model was initially configured with three two-way interactive nested domains. The outermost domain was defined with 33 x 41 grid points at 81-km spacing. This domain was centered near Boise at 43.5°N and 117°W, with standard true latitudes of 60°N and 30°N. The intermediate domain included 31 x 31 points with 27-km spacing; and the inner domain had 34 x 34 points with 9-km spacing. All three domains had 26 layers in the vertical, with the model top at 100 mb (as defined in Section 2). Numerous sensitivity tests (Runs 2 through 11) were undertaken and evaluated using this 3-grid configuration; operating MM5 with 3 grids down to 9-km resolution allowed for many more tests and rapid turn-around than would have been possible with all four grids down to 1-km resolution.

The fourth one-way nested grid with 1 km grid point spacing was run with the final model configuration (Run 11). Results from the final 9-km model output fields were used to provided boundary conditions for the fourth grid. This innermost domain had 100 x 109 grid points and also 26 vertical sigma levels. Results from the 1-km grid were used as inputs to the CAMx air quality model. The horizontal configuration of the three domains is shown in Figure 3-1.

3.3 SIMULATION DEVELOPMENT

3.3.1 Initialization

The model was initialized with the large-scale NNRP analysis data. The data were available every six hours, archived on a 2.5 by 2.5 degree latitude/longitude grid. The lateral boundary conditions were specified by interpolating the same analysis data temporally to each time step, and spatially to the boundaries of the coarsest 81-km grid (boundary conditions for each inner nested grid were provided by solutions on the next outer grid automatically within MM5). The FDDA analysis nudging was also based on this data. The model was integrated from 1200 UTC 1 January to 1200 UTC 10 January with a time step of 240 seconds on the outermost domain.

3.3.2 Physics Configuration

In Run 1, the model physics and FDDA configuration included:

- The simple ice microphysics on all grids to represent resolved-scale moist physics (explicit moisture) for clouds and precipitation;
- The Grell cumulus parameterization scheme in the outer three grids (81, 27, and 9-km meshes) to treat sub-grid scale convective clouds and precipitation (convection is explicitly resolved on grids with ~10 km resolution or better);
- The cloud-radiation scheme on all grids to determine vertical solar and radiative transfer through the atmosphere (this approach accounts for the solar effects of clouds);
- The high resolution Blackadar scheme on all grids to treat convectively and mechanically produced turbulent fluxes of momentum, heat, and moisture in the surface boundary layer (within ~1000 m of the surface);
- The simple slab land-surface model on all grids to treat the surface temperature/energy budget;
- The FDDA analysis nudging toward NNRP analyses above ~1500 m (above the boundary layer) on all grids to suppress model drift in the upper free atmosphere, an area that controls the large-scale dynamics of the atmosphere.

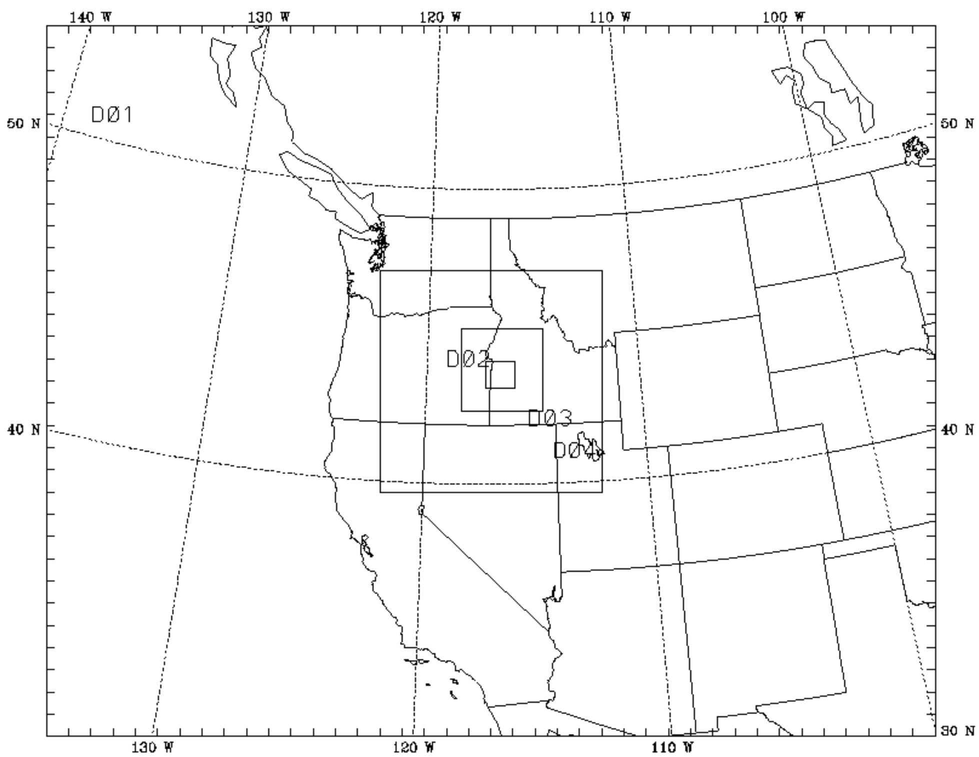

Figure 3-1. Horizontal configuration of MM5 modeling domains for the January 1991 simulations. The outermost domain covers western North America at 81 km grid spacing; domain 2 is the first inner nest with 27 km grid spacing; domain 3 has 9 km spacing, and the innermost domain 4 has 1 km spacing and covers just the air quality modeling domain. The placement of domain labels from NCAR graphics are not accurate.

3.3.3 Designs and Qualitative Results of Sensitivity Tests

The model results of Run 1 were evaluated using the 9-km domain output. The predicted surface fields (temperature, wind direction and speed, and humidity) were compared to the surface observations from the Boise airport. The comparison showed that the wind speed was over predicted through most of the simulation with wind speed bias reaching 6 m/s. Surface temperature and humidity were also over predicted with temperature bias as high as 15 K.

Several test runs were performed with the "rapid radiative transfer model" (RRTM) option to replace the "cloud-radiation" approach, and with FDDA nudging toward NNRP analyses on the coarse 81-km grid only, due to the NNRP's coarse resolution. These runs showed insignificant effects relative to Run 1.

Since the NNRP data consist of large-scale analysis with very coarse resolution, the mesoscale features cannot be well represented. Therefore, standard NWS surface and upper air observations were obtained from NCAR to improve the low-resolution NNRP data with local mesoscale details. A preprocessor available with the MM5 system (RAWINS) was used to blend the surface and upper-air observations with the NNRP data on each MM5 grid using objective analysis techniques. Thus, the initial and lateral conditions, as well as the inputs for FDDA grid nudging, were all improved. The biases between the new model run with the improved inputs and the observations of surface temperature, wind, and humidity decreased substantially, but the errors remained larger than is typically acceptable for use in air quality modeling.

A sensitivity test examined the effects of the bucket soil moisture model. This approach simulates time-varying soil moisture according to atmospheric conditions, whereas the slab soil model maintains a constant soil moisture set to land use dependent defaults. Results with the bucket soil moisture option were mixed. The use of this scheme lowered the wind speed substantially, improving model performance, particularly between January 7 and 9. However, it also raised the already over predicted surface humidity over Boise. Temperatures results were mixed. Since the bucket soil moisture scheme did not improve the predicted surface humidity, this feature was not used in the final simulation.

The over predictions in surface temperature, especially during the overnight hours, led us to believe that the model was not adequately simulating cold air drainage from the snow-covered mountains north and east of Boise to the valley floor. In MM5, thealbedo over areas covered by snow is set between 0.18 and 0.50, depending on the land use type. MM5 also sets the ground moisture availability to 95% wherever snow is present, regardless of the land use type. Moisture in areas without snow is set between 5% and 90%. We believed that if thealbedo was higher and the ground moisture availability was lower, then the cooler and drier air over the higher terrain would be more likely to drain towards the valley floor. The combination of these two modifications in the code lowered Boise's temperatures by nearly 5 K on January 4 and 5 -- the days with the lowest wind speeds. On the other days, they made no significant impact. The moisture content also improved only on those two dates. The diurnal variation in humidity was suppressed during the first 5 days of the simulation.

Further investigation on the vertical profiles (Appendix A) of temperature, wind speed and direction, and humidity from the Boise rawinsonde data showed that the model was performing well above the boundary layer (~ 1000 m) with reasonable agreement between predictions and observations. Only near the surface did the model simulations overestimate the surface variables largely, and with a weaker diurnal variation than observed. We inferred that two model configurations in the above simulations might have contributed to the over estimations. First, the simple slab land-surface model has several weaknesses: absence of snow effects, relatively coarse resolution in terms of land-use types, constant soil moisture field, and no vegetative evapotranspiration and runoff process, all of which might have accounted for the poor model performance. Second, the FDDA grid nudging was only applied to the upper levels above ~ 1500 m. Previous experiments and literature (Stauffer and Seaman, 1991) indicate that nudging of surface wind and moisture throughout the modeled boundary layer is generally better to resolve the low-level structure and movement of atmospheric systems.

Based upon the above analysis, a more sophisticated land-surface model, the Oregon State University Land-Surface Model (OSU LSM), was employed. This LSM is currently used in the NCEP operational Eta forecasting model, and a similar version of this LSM is also used in the NCEP Medium-Range Forecast model (MRF). The OSU LSM can utilize high-resolution vegetation and soil maps, and time varying soil moisture and snow fields. Verified with long-term observations, this model has been able to reasonably reproduce the observed diurnal variation of sensible heat fluxes and surface skin temperature, which are crucial to estimate the surface atmospheric variables of temperature, moisture and wind. Currently, only the MRF and ETA boundary layer options are coupled with the OSU LSM approach. Therefore, we chose the MRF option for the new MM5 configuration. We also adjusted the soil moisture in the initialization procedure of MM5 to correct for a known bias in the NNRP input dataset. The new MM5 simulation incorporating all of these changes resulted in a much better reproduction of the observed surface and humidity diurnal amplitude. However, the overestimation bias still persisted through the entire simulation period.

Since this episode spans period of nine days, the accumulation of numerical errors becomes a serious problem for model performance. FDDA has become an effective tool for air quality applications by introducing observational data into the prognostic meteorological model throughout the simulation to reduce the growth of model errors. Although FDDA was applied for levels above ~ 1500 m in previous tests, the numerical errors accumulated in the near surface levels appeared to significant; the likely cause of this could be the extreme static stability observed and simulated during the episode, which decouples the atmosphere sufficiently such that the near surface regime becomes a completely separate simulation reacting to its own set of small-scale forcings.

Therefore, the combined NNRP analyses and NCEP surface observation input datasets were used to nudge the MM5 for winds, temperature, and moisture at the surface and within the boundary layer on the 81, 27 and 9-km grids. The results from this run showed dramatic improvements in the prediction of surface winds, and especially temperature and moisture. By further tuning up the nudging strength, the biases were reduced to reasonable levels, although the wind speed bias remained relatively high. Of course, the error reductions achieved with stronger nudging is a self-fulfilling prophecy, as the model is nudged directory toward the observations that are used in the error calculations. At least we have some assurances that the simulation faithfully reflects the conditions where they are observed, and that the influence of those observations are incorporated into the simulation elsewhere in the domain.

Another approach of the FDDA technique was incorporated to further control the wind bias. MM5 offers the ability to nudge directly toward individual point observations, which is referred to as "observational" or "point" nudging, as opposed to the "analysis" nudging carried out to this point. This approach nudges the simulation locally in the area and time window of each individual measurement, thereby including the effect of the observations directly into the simulation. Observational nudging is better suited for assimilating high-frequency (such as hourly) local "asynoptic" data. The NWS Boise Airport site includes hourly surface observations of temperature, moisture, and wind. We applied surface observational nudging of the wind data on the 9-km grid (and ultimately on the final 1-km grid used for air quality modeling). As expected, this reduced the simulated wind speeds quite effectively, and improved wind directions, throughout the Treasure Valley (Run 11).

3.3.4 Final Approach

The model configuration of the final run (Run 11) is summarized as follows:

- The simple ice microphysics on all grids to represent resolved-scale moist physics (explicit moisture) for clouds and precipitation;
- The Grell cumulus parameterization scheme in the outer three grids (81, 27, and 9-km meshes) to treat the sub-scale convective clouds and precipitation;
- The cloud-radiation scheme on all grids to determine vertical solar and radiative transfer through the atmosphere;
- The MRF scheme on all grids to treat convectively and mechanically produced turbulent fluxes of momentum, heat, and moisture in the surface boundary layer;
- The OSU land-surface model on all grids to treat the surface temperature/energy budget;
- The FDDA surface and three-dimensional analysis nudging toward blended NNRP analyses and regional surface and upper air observations on the outer three grids (81, 27, and 9-km meshes), and FDDA observational nudging of surface wind at the Boise airport in the 9-km grids only.

Run 11 also introduced the finest 1-km mesh, upon which MM5 generated the gridded meteorological fields used in CAMx. The results from the 9-km grid were extracted using standard MM5 one-way nesting software to generate the initial and lateral boundary conditions for the 1-km grid. The same model physics as those listed above for the larger grids were applied, except that the Grell cumulus parameterization scheme was turned off. Three-dimensional FDDA analysis nudging of wind, moisture and temperature was applied 2-hourly through the whole simulation period, and surface observational nudging of wind at the Boise airport was invoked, as in the 9-km grid. A detailed discussion of the performance and evaluation of this simulation is given next.

3.4 STATISTICAL EVALUATION – RUN 11 VS. RUN 1

Hourly and daily statistical measures were calculated to compare simulated surface winds, temperature, and humidity to observations taken at the NWS Boise airport site. Statistics were determined from the 9-km results in Run 1 and Run 11 to show the improvements between the initial and final MM5 applications. For consistency, the 9-km gridded fields were statistically analyzed since that was the finest resolution grid used in Run 1. Statistical results for Run 11 on the 1-km grid were quite similar to the 9-km results.

While strict performance goals have been established by the EPA for acceptable ozone model performance, no numerical performance "benchmarks" have been considered to determine acceptable prognostic meteorological model behavior, despite the now widespread use of such models to define critical inputs to the air quality models. Recognizing the need to judge meteorological statistical performance against some type of standard, in 2001 the state of Texas sponsored the development of a set of daily performance benchmarks for typical meteorological model performance (Emery et al., 2001). These standards were based upon the evaluation of a variety of about 30 MM5 and RAMS applications for summertime ozone and regional PM modeling, undertaken throughout the country within the last few years, as reported by Tesche et al. (2001).

The purpose of the benchmarks was not necessarily to give a passing or failing grade to any one particular meteorological model application, but rather to put its results into the proper context. For example, expectations for modeling coastal areas of Texas in the summer would be quite different from modeling an autumn stagnation event in the inter-mountain west. The key to the benchmarks is to understand how poor or good the results are relative to the universe of other model applications run in other areas of the U.S. Certainly, an important criticism of the EPA guidance statistics for acceptable photochemical performance is that they are relied upon much too heavily to establish an "acceptable" model simulation of a given area and episode. Often lost in the statistical evaluation is the need to critically evaluate all aspects of the model via diagnostic and process-oriented approaches. The same must be stressed for meteorological performance evaluation.

Given the lack of any other standard for judging MM5 performance, we have adopted the daily statistical benchmarks developed by Emery et al. (2001) for this study:

Wind Speed	RMSE:	≤ 2 m/s
	Bias:	≤ ±0.5 m/s
	IOA:	≥ 0.6
Wind Direction	Gross Error:	≤ 30 deg
	Bias:	≤ ±10 deg
Temperature	Gross Error:	≤ 2 K
	Bias:	≤ ±0.5 K
	IOA:	≥ 0.8
Humidity	Gross Error:	≤ 2 g/kg
	Bias:	≤ ±1 g/kg
	IOA:	≥ 0.6

where RMSE is root-mean square error, and IOA is the unitless "Index of Agreement", which varies from 0 (poor) to 1 (perfect). In retrospect, certain values listed above are likely to be inappropriate for wintertime stagnation events. These include the benchmarks for wind direction and humidity. Wind directions in near-calm conditions are highly variable and predictions are usually associated with rather high error, so both of the direction benchmarks are probably too stringent. Absolute humidity levels in near freezing temperatures are at or below the absolute errors listed above, so they are too lenient. These situations are noted below.

3.4.1 Hourly Statistics

Figure 3-2 shows the hourly statistical performance for surface winds, temperature, and humidity at the Boise NWS site from Run 11 (red trace) and Run 1 (blue trace). Note that hourly statistics for this episode do not include error metrics that depend upon a linear regression since only a single observation-prediction pairing per hour was available (regression requires at least 3 data pairings). Starting with surface winds (Figure 3-2a), the light wind conditions during the whole episode were simulated well in Run 11 with observed and predicted wind speeds remaining below 5 m/s over most of the episode. The noticeable feature concerning the wind observations is that both wind speed and direction fluctuated frequently, and there were many calm situations during the episode. It is very difficult for numerical models to simulate stochastic behavior such as this, as they only respond to the forcings that they can resolve on the grid scales. Therefore, models such as MM5 tend to smooth out small-scale perturbations, and are rarely capable of simulating absolute calm conditions. Wind speeds are over predicted during most of the episode in Run 1.

The hourly temperature time series of Run 11 (Figure 3-2b) show that the diurnal variation and its amplitude were well replicated, especially during the early days of the episode. The trend of the temperature change during this 9-day period, i.e., slowly decreasing until January 5 then slowly increasing after that, was also reproduced. Although the over estimation of temperature as high as 8 K still exists, it is significantly reduced compared to that of Run 1. The hourly time series of temperature from Run 1 shows very weak diurnal cycle and no trend in temperature change.

The nighttime temperature bias was generally lower than the daytime bias. The predicted daytime temperature increased too fast and too high, causing the boundary layer to heat too quickly. The observations from daily weather maps and the Boise NWS site show that foggy weather persisted in the morning of most days of this episode. Fog normally blocks solar radiation and prevents quick boundary layer heating. However, the foggy weather was not simulated by the model.

The hourly time series of humidity is displayed in the Figure 3-2c. Humidity was simulated rather well, with prediction biases below 1 g/kg over the whole episode, except January 8 and 9 when snow was observed to occur on these two days. The observed diurnal range was well replicated in Run 11 compared to that of Run 1. Humidity was highly over predicted in Run 1, especially on January 5 and the later days of the episode.

It is worth mentioning that there was a slow increasing trend for both temperature and humidity during the last 4 days of the episode (starting January 6). The diurnal variations became weaker and less regular in this period too. Although the model reproduced the increasing trend well, it did not capture the weak diurnal range. In contrast, the simulated temperature and humidity fluctuated irregularly starting January 7. The reasons for this behavior are not clear, but could be related to the poor simulation of clouds/fog in the model.

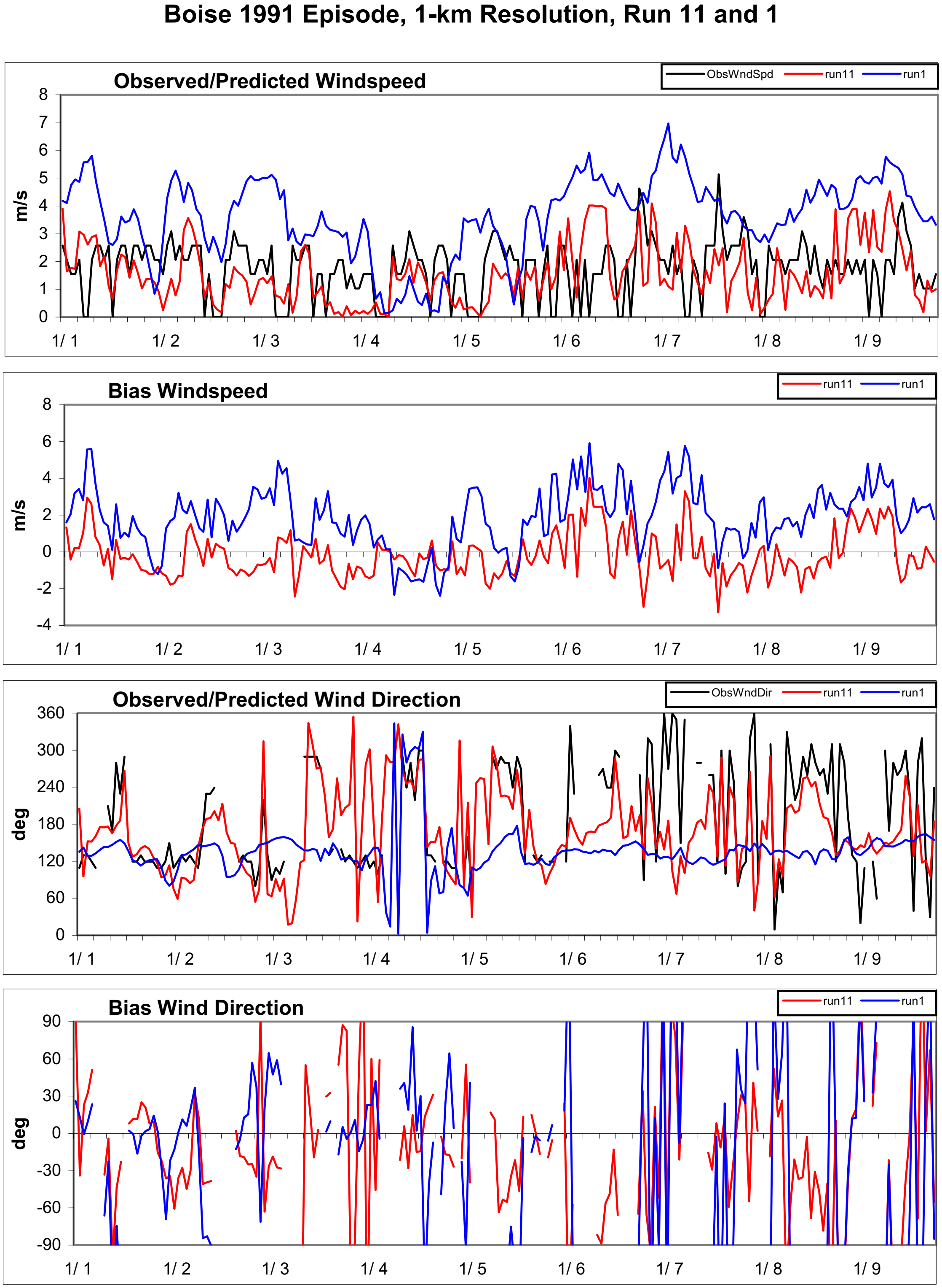

Figure 3-2a. Hourly observed and predicted (Run 1 and 11) surface-layer winds and bias in the 1-km MM5 domain over the January 1991 modeling episode.

Boise 1991 Episode, 1-km Resolution, Run 11 and 1

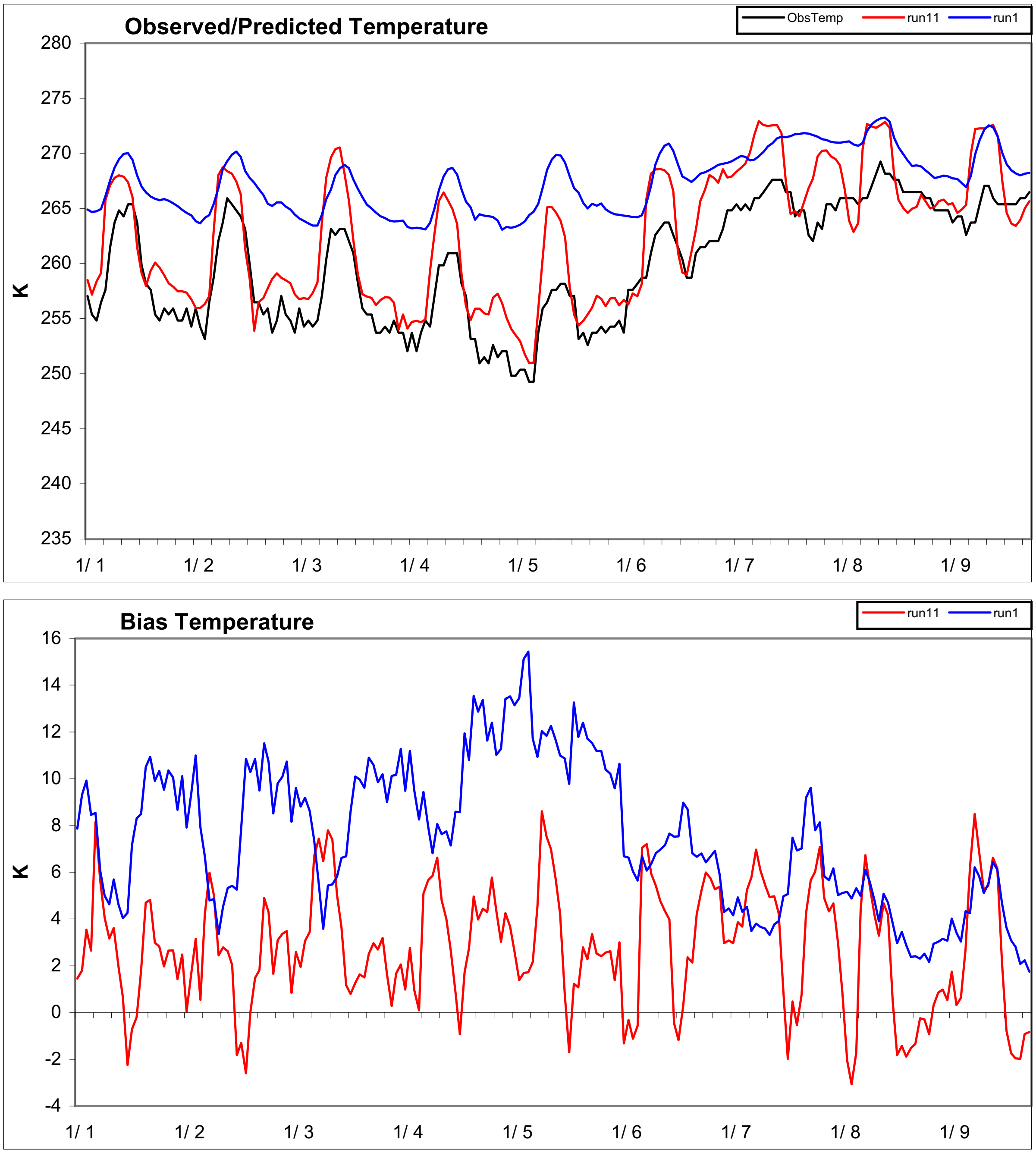

Figure 3-2b. Hourly observed and predicted (Run 1 and 11) surface-layer temperature and bias statistics in the 1-km MM5 domain over the January 1991 modeling episode.

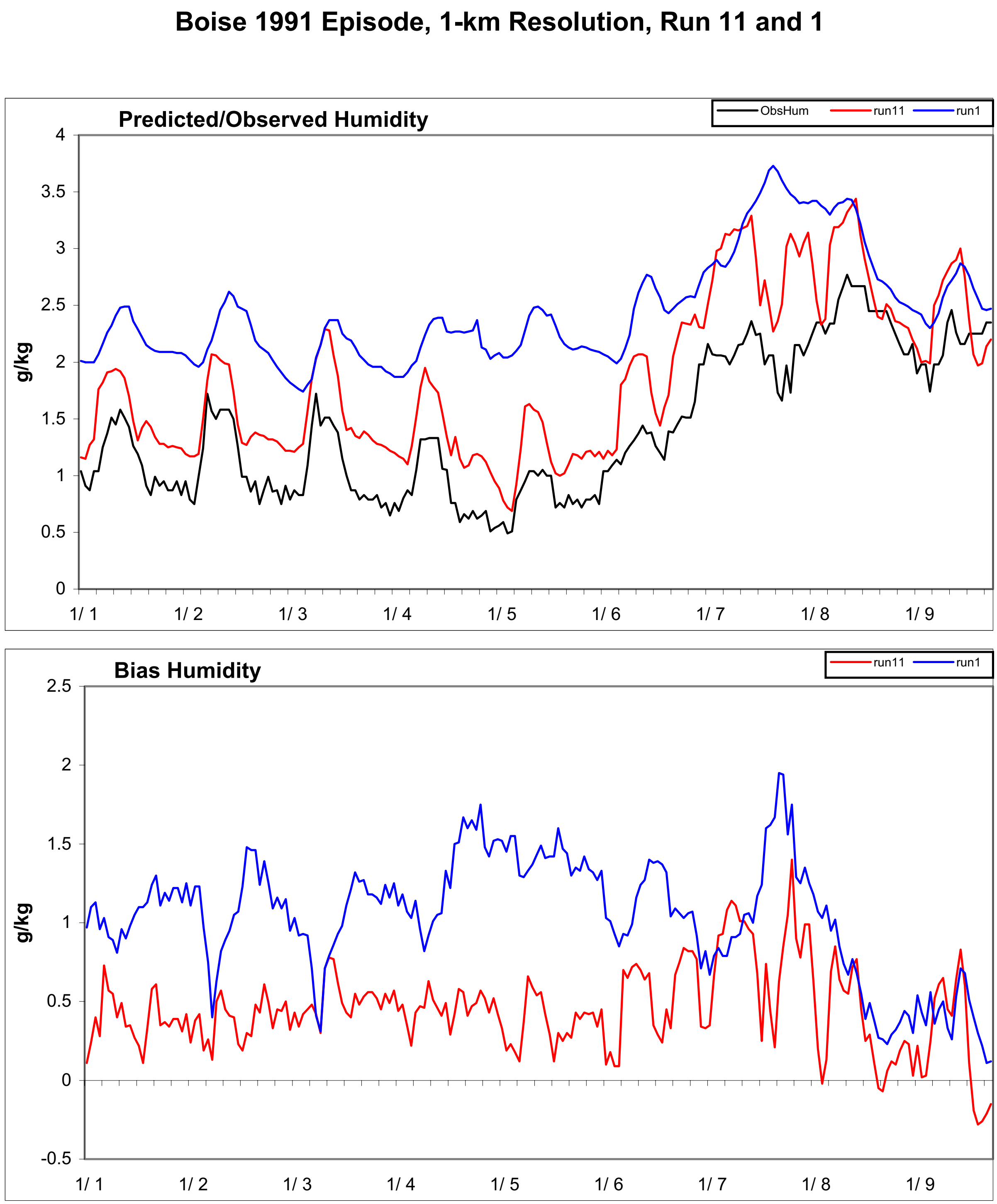

Figure 3-2c. Hourly observed and predicted (Run 1 and 11) surface-layer humidity and bias in the 1-km MM5 domain over the January 1991 modeling episode.

3.4.2 Daily Statistics

Daily statistical results for Run 11 (red bars) and Run 1 (black bars) on the 1-km grid are presented in Figure 3-3 for winds, temperature, and humidity. The Run 11 model performance for wind (Figure 3-3a) was good, especially the light wind speeds were reproduced well. Both RMSE and bias for speed met performance benchmarks proposed by Emery et al. (2001). The Index of Agreement (IOA) benchmark for the wind speed was marginally met. The bias and gross error for wind direction were relative high compared to the benchmark, although our recent experience indicates that the benchmarks for wind direction are clearly too restrictive. The major reason for the larger errors associated with wind direction is that the model cannot replicate the highly stochastic behavior in the observations in calm conditions. The comparison of Run 11 with Run 1 shows that model performance improved significantly with the various modifications.

The daily statistics of temperature are shown in Figure 3-3b. Although the overestimation of temperature was largely reduced in Run 11 during all days of this episode, the bias and gross error of temperature were still relatively high compared to the benchmark. The temperature IOA reached as high as 0.9. However, the episode mean of 0.67 was still lower than the benchmark.

Figure 3-3c shows the daily statistics of humidity. The humidity trend was replicated well over the whole episode, with the gross error and bias well within the benchmark. Since the error and bias benchmarks are in absolute units and were set for warmer climates, they are not particularly relevant to the cold dry conditions in wintertime Boise. The benchmark of humidity IOA was also marginally met.

A listing of the range and mean daily statistics from Run 11 is displayed in the following table, along with the benchmarks.

Parameter	Benchmark	Range	Episode Mean
Wind Speed RMSE, m/s	2.0	1.0 – 1.7	1.2
Wind Speed Bias, m/s	±0.5	-0.7 – 1.0	-0.2
Wind Speed IOA	0.60	0.45 – 0.70	0.58
Wind Direction Gross Error, deg	30	27 – 73	48
Wind Direction Bias, deg	±10	-45 – 3	-15
Temperature Gross Error, K	2.0	2.4 – 4.1	3.2
Temperature Bias, K	±0.5	1.9 – 3.8	2.8
Temperature IOA	0.8	0.3 – 0.9	0.7
Humidity Gross Error, g/kg	2.0	0.3 – 0.7	0.5
Humidity Bias, g/kg	±1.0	0.2 – 0.7	0.5
Humidity IOA	0.60	0.37 – 0.76	0.56

Boise 1991 Episode -- Run 1_1km and Run 11_1km.

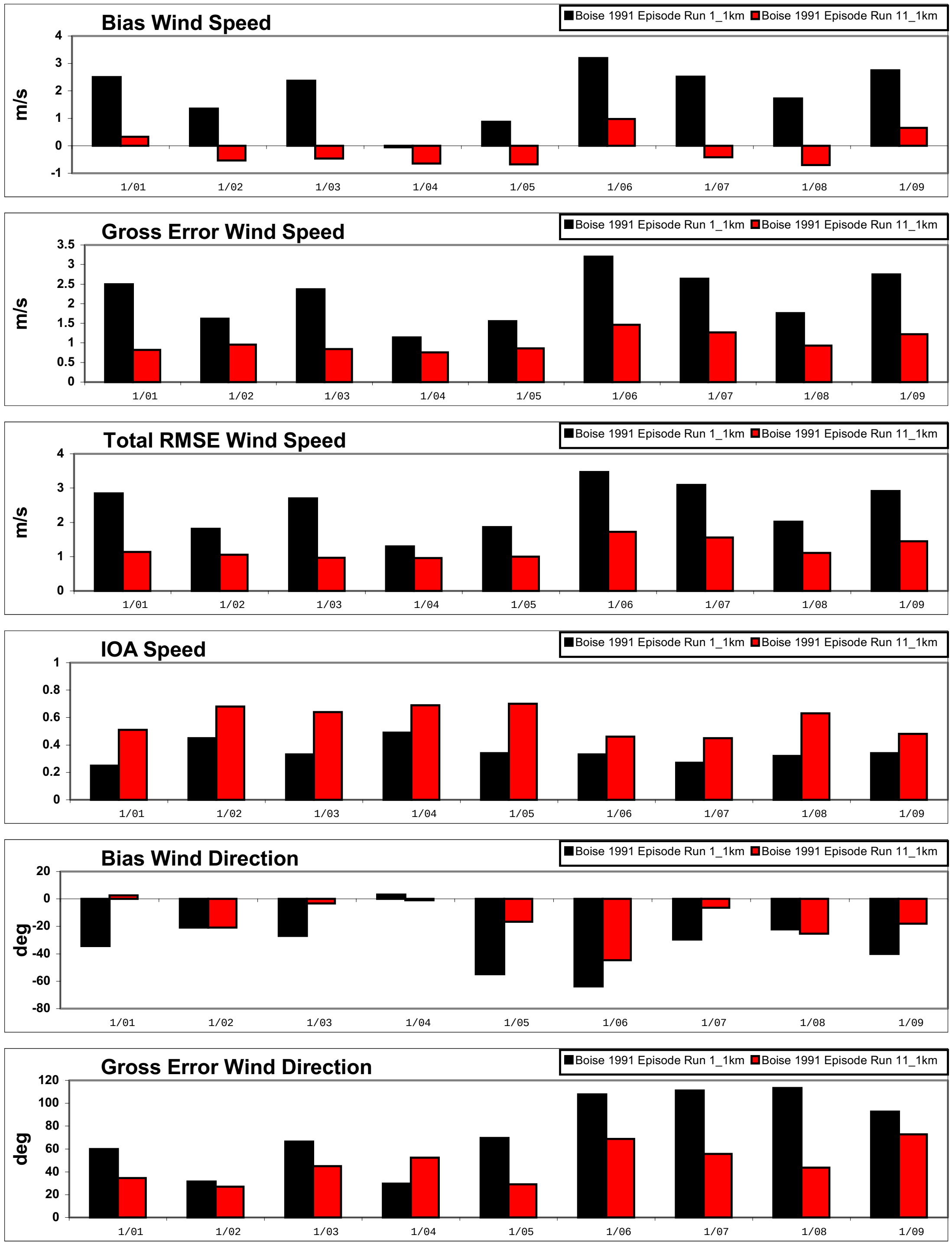

Figure 3-3a. Daily average Run 1 and 11 performance statistics for surface-layer winds in the 1-km MM5 domain over the January 1991 modeling episode.

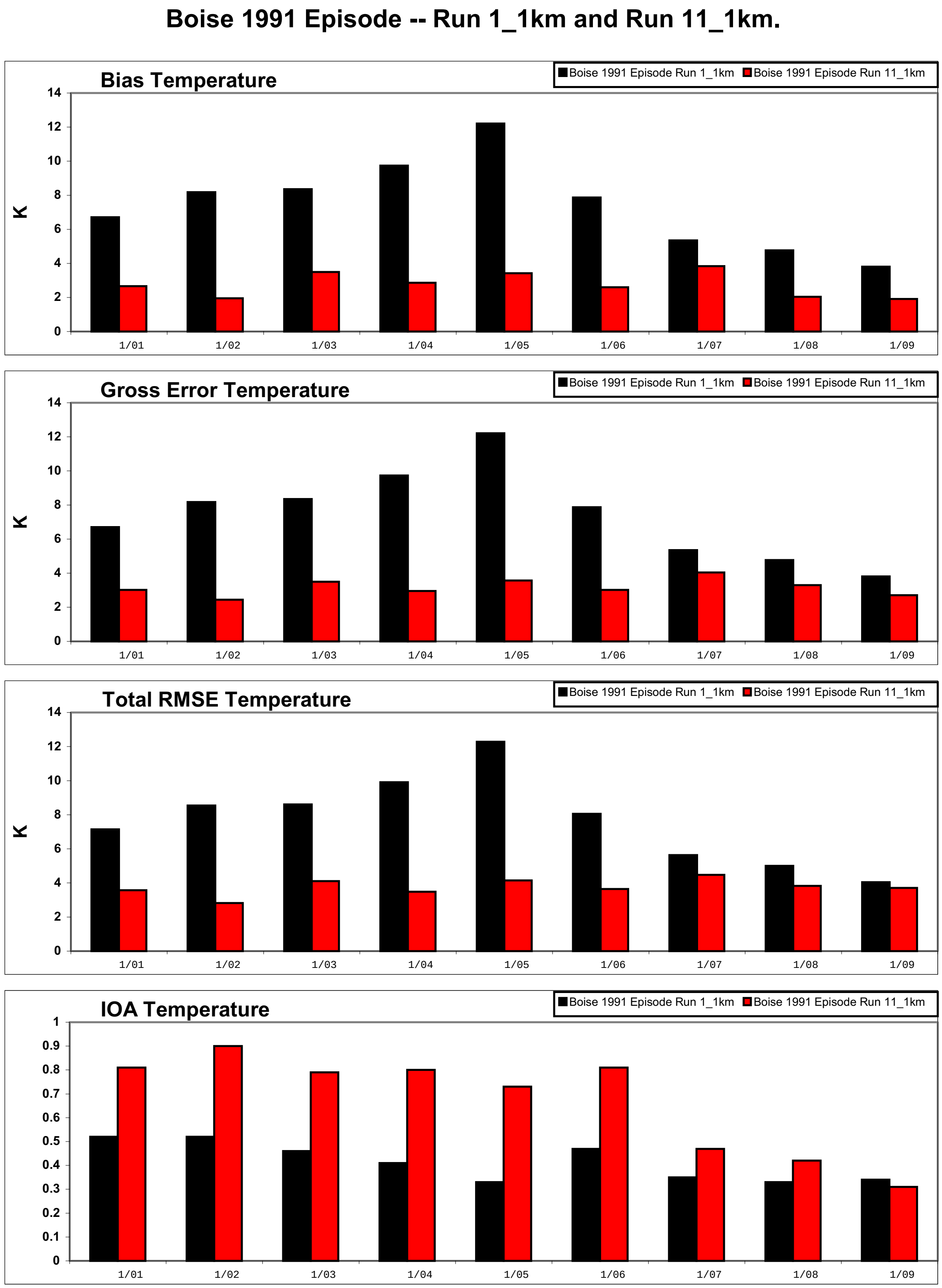

Figure 3-3b. Daily average Run 1 and 11 performance statistics for surface-layer temperature in the 1-km MM5 domain over the January 1991 modeling episode.

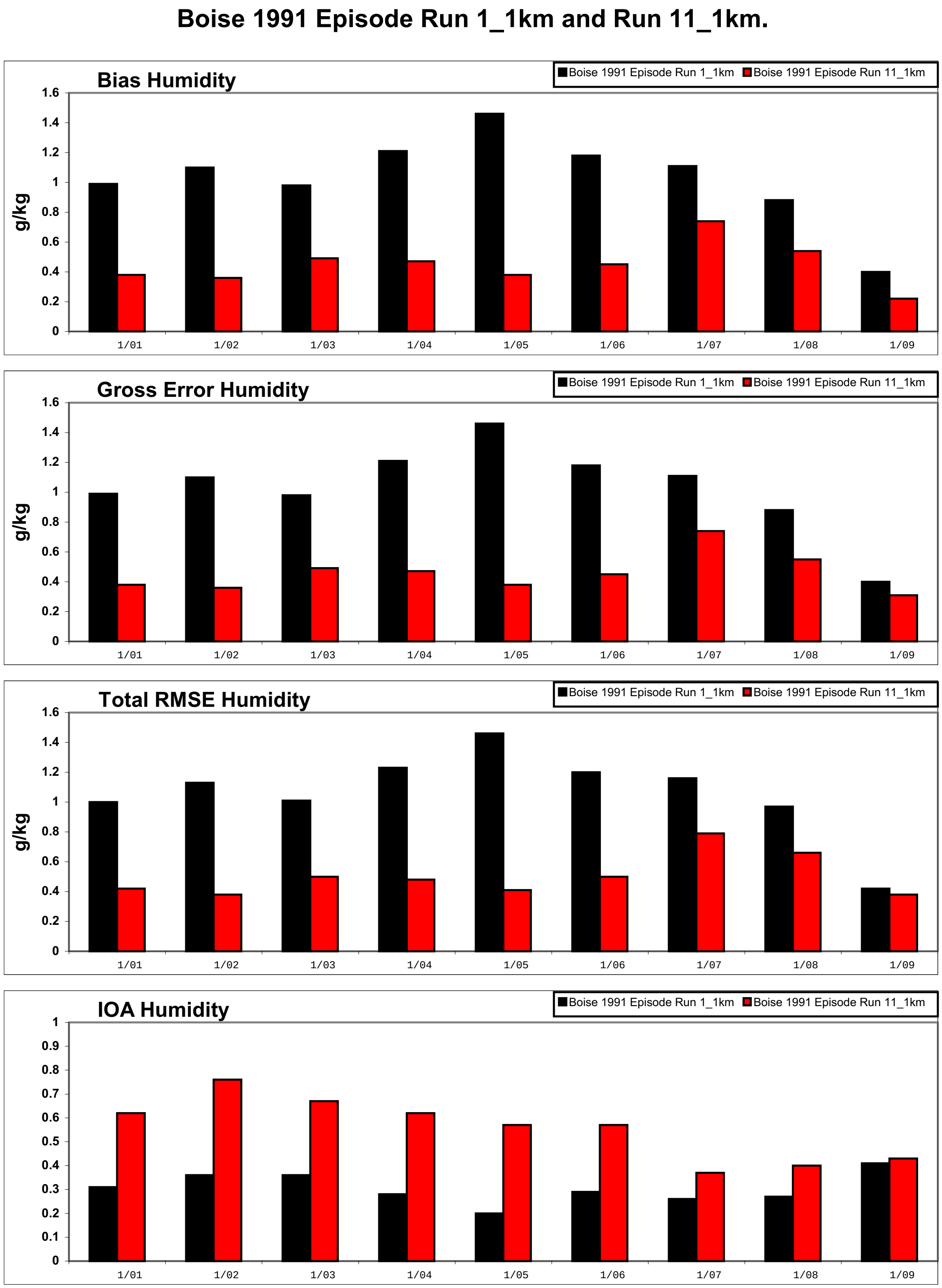

Figure 3-3c. Daily average Run 1 and 11 performance statistics for surface-layer humidity in the 1-km MM5 domain over the January 1991 modeling episode.

3.5 GRAPHICAL EVALUATION

The vertical profiles of predicted and observed wind speed and direction, temperature, and humidity at the NWS Boise airport site are presented in Appendix A. Overall, the vertical structures of wind, temperature, and humidity were simulated well, especially for high levels above the boundary layer. This gives us confidence that the overlying large-scale influences causing the stagnation event were well characterized in MM5. The depth of the daily mixed layer is simulated to be quite shallow during the episode, in agreement with the observations.

Appendix C displays plots of the horizontal surface-layer winds and temperature fields on the 1-km CAMx grid. One plot per episode day is shown at noon local time. Plots of winds show vectors indicating direction and speed (arrow length); color contouring also shows the distribution of wind speed. The MM5 simulation for Run 11 shows consistent stagnation on the valley floor, with some topographically-induced flows, and occasional higher winds in the elevated terrain. Plots of cloud/fog cover are not shown as MM5 did not generate any significant cloud cover during the period.

3.6 QUALITATIVE ANALYSIS

A qualitative assessment of surface wind, temperature, moisture, and sea level pressure from the 81 and 27-km grids of Run 11 was undertaken to verify the model performance in simulating large scale weather patterns and mesoscale features. The model results were compared to Daily Weather Maps (published by National Weather Service) at 0500 Mountain Standard Time (MST) each day. Higher frequency weather charts (as used in evaluating the 1999 episode in Section 4) could not be located back to 1991.

During most days of this episode, persistent high pressure was observed over southwestern Idaho and its vicinity. An extremely cold air mass was associated with this high pressure dome. Temperature as low as –10°F was observed in Boise on the morning of January 5. Morning fog occurred during the whole episode. Surface winds were light and mostly from the southwest and southeast.

The model captured most of these features well. The high pressure, as well as the very cold surface temperature, was simulated over southwestern Idaho. The simulated system was centered slightly to the northwest of the area relative to the observations. The surface light wind conditions were reproduced well with wind speeds below 4 m/s in the Boise area. The model also captured the local mountain/valley circulation. The northeast down slope winds from the northeast and southwest into the Snake River Plain were obvious in the simulated 10-m surface wind field. However, the model did not replicate the daily fog formation.

<u>January 2</u>

At 0500 MST, a broad high pressure system was observed over the western U.S. from Idaho to the Four Corners area with the high centered just to the south of Idaho. An extremely cold air mass (-2°F at Boise and Pocatello) covered the southern half of Idaho, southeast Oregon and north Nevada. Light southeast winds were recorded in Boise.

The predicted sea level pressure field on the 81-km grid showed a weaker high pressure system with several isolated highs in the western U.S. The predicted high pressure on the 27-km grid of 1034 mb over the Boise area was quite close to the analyzed 1035 mb maximum. The surface air temperature over the Boise area from the 27-km grid was slightly over predicted. Although the surface air temperature over Boise from the 1-km grid (Appendix C) was comparable to the observations, the very cold air mass was limited to southern Idaho and northern Nevada. The light southeast wind was captured in both the 27 and 81-km grid simulations. The local mountain/valley circulation was quite strong in the 27-km grid simulation and the model performed well in simulating wind speed and direction.

January 3-4

The high pressure over the Boise area decreased from 1034 mb to 1026 mb over the next two days. No large-scale closed high pressure system was observed over the western U.S. Winds in the Boise area remained from the southeast but became even lighter (1-2 knots).

The light southeast wind was simulated in both the 27 and 81-km grids. The trend of high pressure decrease was captured by the model, while the 27-km simulation generated a closed high pressure system over the area. The predicted surface air temperature over Boise was 3°F, comparable to the observed of 1°F, at 0500 MST January 3. However, the temperature over Boise was somewhat warmer than surrounding areas, with very cold air to the south. The reason for this is not known. On January 4, the strength and location of the cold air mass over Boise area was simulated successfully, with the coldest observed and predicted surface air temperature (-6°F) predicted to the east of Boise.

January 5-6

A systematic high pressure system started to build on January 5. The contour of 1028 mb was analyzed to close around the Boise area. Wind was light and southeasterly on January 5 and 6. Surface air temperature remained low and below zero.

The closed local high pressure around Boise was simulated correctly and the lowest air temperature (-9°F) was also captured in the model simulation.

January 7-10

A low pressure system moved over the coast of northwest Washington on January 7. This system brought rain into most areas of Washington and snow into eastern Washington and western Idaho, including the Boise area. Winds were northerly yet still light on January 7. The high pressure center moved southeastward into Utah on January 7, but moved back over Boise on January 8. This high pressure system was weaker compared to that of January 2. Calm wind conditions occurred on January 8-10. Temperatures were in the upper teens and lower twenties during these days.

Precipitation occurred on January 7 in the model simulation (not shown), although it was spotty and of short duration in the 1-km grid. The wind was also over estimated in the model simulation, since calm wind conditions were reported during the remainder of the episode.

The weaker high pressure system was reproduced well, with pressure in the range of 1024 mb to 1026 mb.

3.7 SUMMARY

A severe stagnant weather event leading to exceedance PM_{10} levels occurred in January 1991. The meteorological conditions during this episode were simulated by MM5 version 3.5. The model was configured with simple ice microphysics, cloud radiation, Grell cumulus parameterization scheme, OSU land surface model, MRF boundary layer scheme, and a multi-scale FDDA nudging technique. Most of the stagnant features, such as light or calm surface winds, extremely cold air mass on the valley floor, and a very stable boundary layer conditions, were captured successfully by the final model simulation (Run 11). The hourly and daily statistical analyses of surface wind, temperature and humidity displayed reasonable performance, although the model slightly over predicted surface temperature and humidity, especially on the last two days. The model did not replicate the presence of nightime/morning fog each day as was observed.

4.0 MODELING THE DECEMBER 1999 EPISODE

4.1 GENERAL OVERVIEW

MM5 was used to simulate the meteorological conditions during a high PM_{10} event that took place from December 20 to 26, 1999. This period was characterized by a large 1050 mb high and light surface winds over Boise. Initially, version 3.4 of MM5 was used to simulate this episode (initial modeling of the December 1999 period was performed prior to modeling of the January 1991 period). The initial run with version 3.4 did not replicate the meteorological conditions well as daytime temperatures were 9 K cooler than observed on the first few days of simulation and up to 6 K warmer than observed by the last day of the simulation. Moisture content was under predicted through most of the simulation, and wind speeds were slightly over predicted. The last run simulated with MM5 version 3.4 will hereafter be referred to as "Run 3."

Subsequently, a new version of MM5 was released; a major feature of version 3.5 is the way the model handles snow cover. In version 3.4, MM5 would not read in the snow cover fields from the large-scale EDAS dataset; in the new version, snow cover is read in and can be updated within the simulation via FDDA inputs. In addition, Version 3.5 includes a simple snow model for the land-surface model to effect the surface heat budget. It was realized that these new features could play a significant role during this wintertime simulation over mountainous terrain. Numerous sensitivity tests using MM5 version 3.5 were performed for the 1991 episode, as described in section 3. Instead of duplicating those efforts, the final 1999 simulation with version 3.5 was based on the configuration that yielded the best performance in 1991. This run will hereafter be referred to as "Run 4."

4.2 DOMAIN AND MODEL CONFIGURATION

MM5 was configured with 4 grids. The coarse grid spanned 29 by 29 grid points at a 27-km resolution, covering most of Idaho, eastern Oregon and northern Nevada. The domain was centered near Boise at 43.5°N and 117°W, with standard true latitudes of 60°N and 30°N. The use of a smaller and finer resolved coarse grid relative to that used for the 1991 episode was based on the better space and time resolution afforded with the EDAS dataset over the NNRP dataset. Figure 4-1 shows the modeling domain with the positions of the nested grids. Three nested grids at 9, 3, and 1 km resolution allowed more detail to be resolved around Boise. The 9 and 1-km domains were identical to those used in the January 1991 simulation; the 1-km domain spanned 97 by 94 grid points. The smaller domains and fewer simulations undertaken to develop the 1999 episode meteorology allowed two-way nesting to be used between all the domains. However, this required the additional 3-km intermediate domain as two-way nesting requires a 3:1 nesting ratio among successive nests. The model was configured with the same 26 vertical layers as the 1991 simulation with 9 layers used to represent the boundary layer, assumed to be levels below 850 mb (~1500 m).

Run 3 (MM5 version 3.4) was configured with the Gayno-Seaman boundary layer scheme, cloud radiation, and Reisner mixed phase moisture schemes. The Kain-Fritsch sub-scale cumulus scheme was used only in the two coarsest grids (27- and 9-km). Analysis nudging

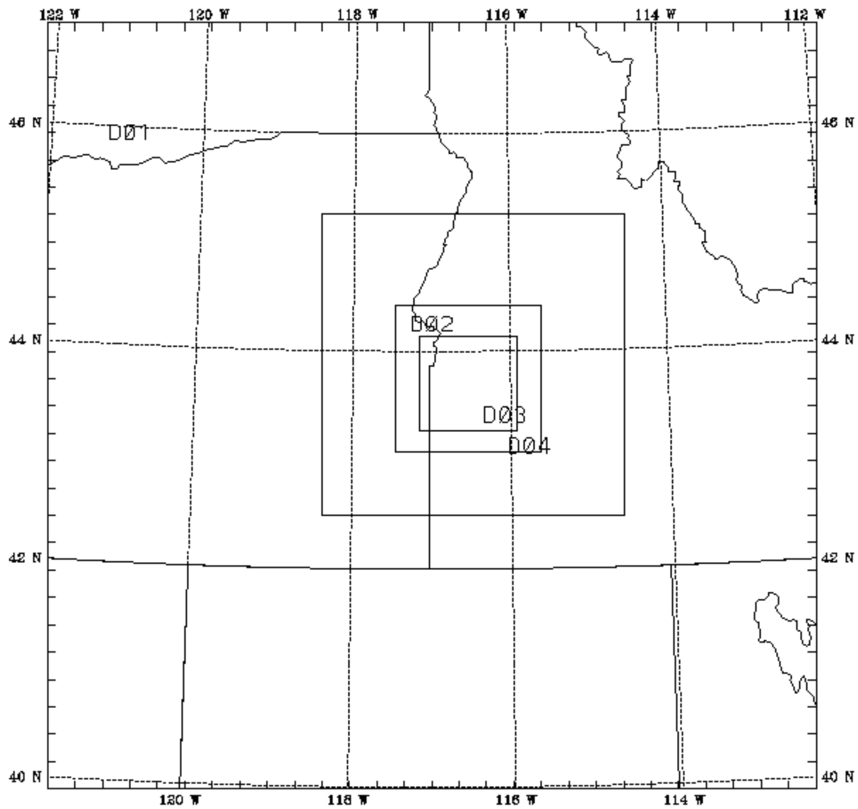

Figure 4.1. Depiction of the domain coverages of the 27/9/3/1km-resolution grids used for the 1999 MM5 simulations.

was applied to the 27 and 9 km domains every three hours using the 40 km resolution EDAS fields, with coarser NNRP data to fill in some missing gaps, and regional NCEP upper air and surface observations to improve the analysis nudging fields. Observational nudging using data from two surface sites – Boise Airport and Boise Fairgrounds – and the Boise upper air site was applied on the 1-km domain. MM5 version 3.4 was modified to account for the lack of snow cover by changing the landuse category in any area above 1500 m to snow.

Run 4 (MM5 version 3.5) used the MRF boundary layer scheme coupled with the OSU land-surface model. The cloud radiation and simple ice moisture schemes were also selected. The Grell cumulus parameterization scheme was activated only on the 27 and 9 km grids. Strong analysis nudging was used on all four domains and very strong observational nudging was applied to the 1 km domain.

4.3 STATISTICAL EVALUATION

Surface observations were available from three meteorological stations located inside the 1-km grid for the 1999 episode – Boise Airport, Boise Fairgrounds, and Caldwell airport. A composite of these three sites was used to compare the surface wind, temperature, and humidity to the predicted values extracted from the 1-km grid of Runs 3 and 4. The daily statistical results are compared to performance benchmarks as in Section 3.

4.3.1 Hourly Statistics

Time series of the composite hourly wind, temperature, and humidity statistics are displayed in Figure 4-2. On four of the first five days of simulation, the observed wind speed was distinctively stronger in the afternoon compared to the rest of the day. The strongest peaks occurred on December 20 and 21, when the observed afternoon wind exceeded 5 m/s. On those two dates, Run 3 predicted afternoon peaks much slower than the observed. Run 4 replicated the diurnal pattern better, although the peaks were slightly under predicted. From December 22 to 24, Run 3 simulated the weaker afternoon peaks better than Run 4; both overestimated the wind in the mornings. On the last two days of simulation – December 25 and 26 -- most observations were less than 1 m/s. Both runs over predicted the speed, particularly Run 3. Overall, both runs had a wind speed bias within ±2 m/s during most hours of the simulation. Run 3 bias exceeded ±3 m/s briefly four times during the episode while Run 4 exceeded it only once.

From December 20 to 24, the observed wind direction was predominantly northwesterly on all afternoons. MM5 replicated this well in both runs except in Run 4 on December 23, which simulated a weak southeasterly afternoon wind. In the mornings, Run 4 correctly predicted westerlies from December 20 to 22, and southeasterlies on December 23 and 24. Run 3 generated similar results except the direction was southeasterly on December 22. On the last two dates, the light wind speed made both the predicted and observed hourly wind direction highly variable in time and out of agreement. The observations seemed to favor westerlies. Run 3 showed no predominant direction while Run 4 favored northerlies and easterlies. Figure 4-2 suggests that, except for a few key periods, overall the two runs were not particularly different for winds.

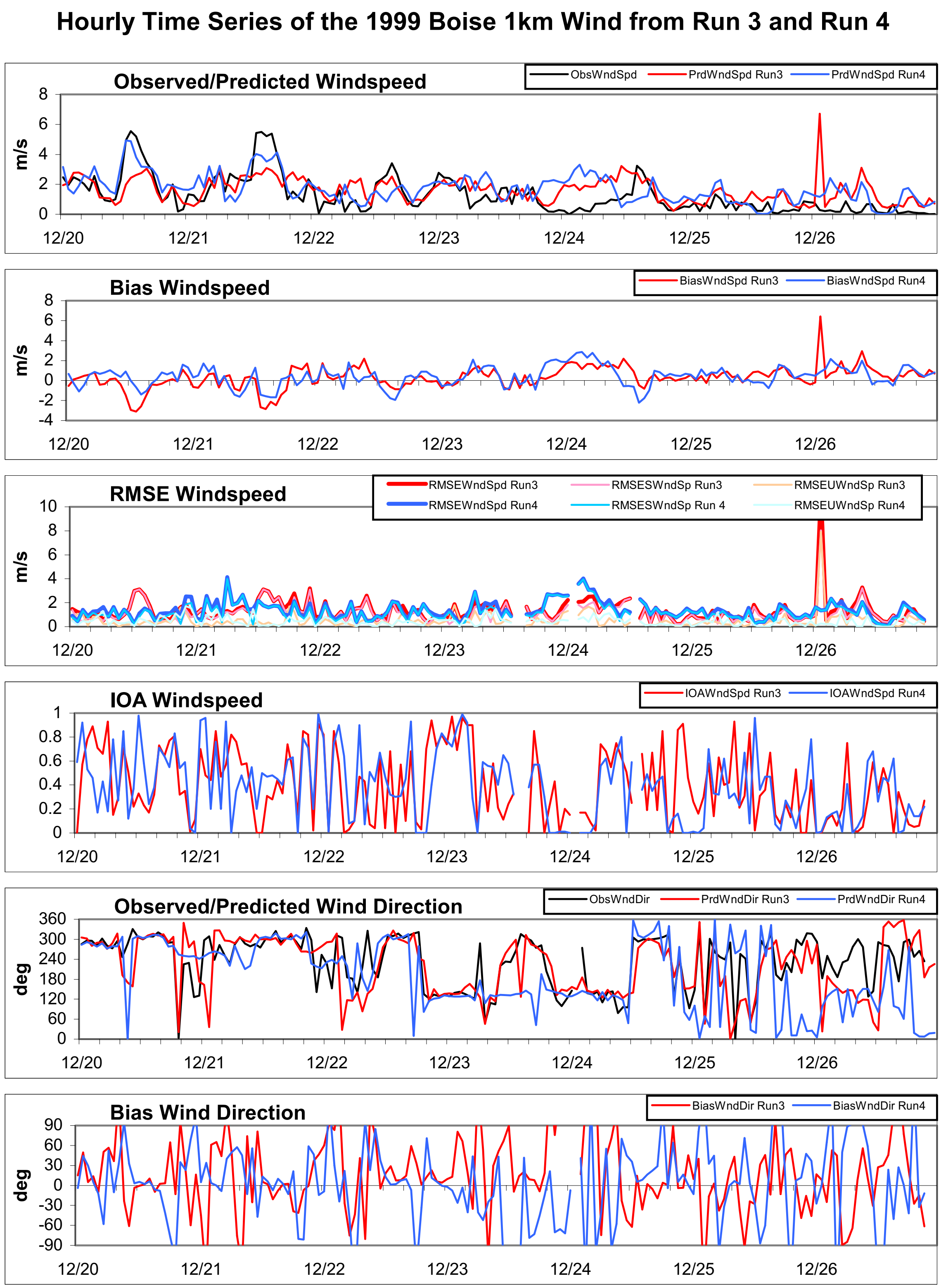

Figure 4-2a. Hourly composite surface wind field statistics from Runs 3 and 4 of the December 1999 simulation.

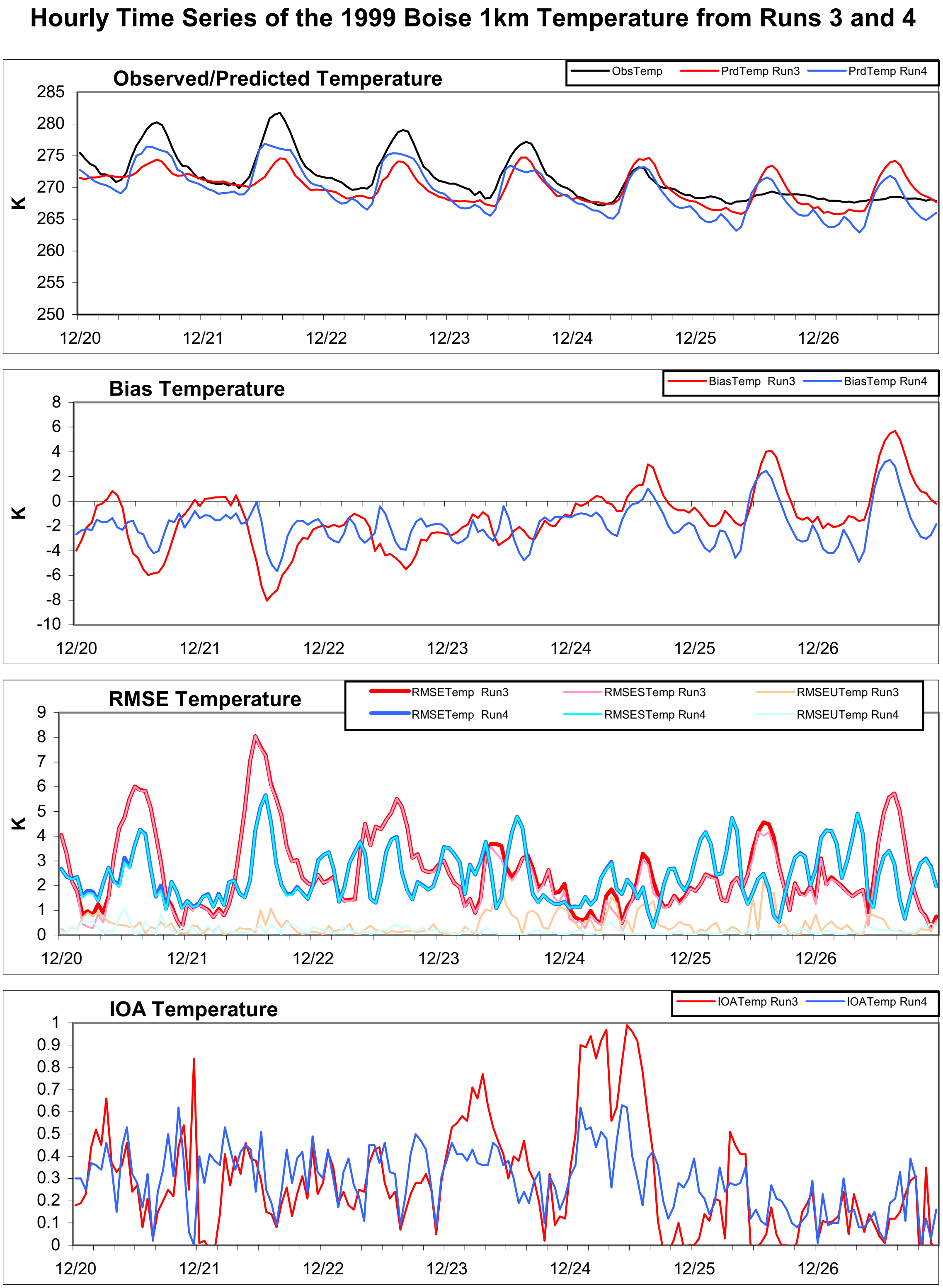

Figure 4-2b. Hourly composite surface temperature statistics from Runs 3 and 4 of the December 1999 simulation.

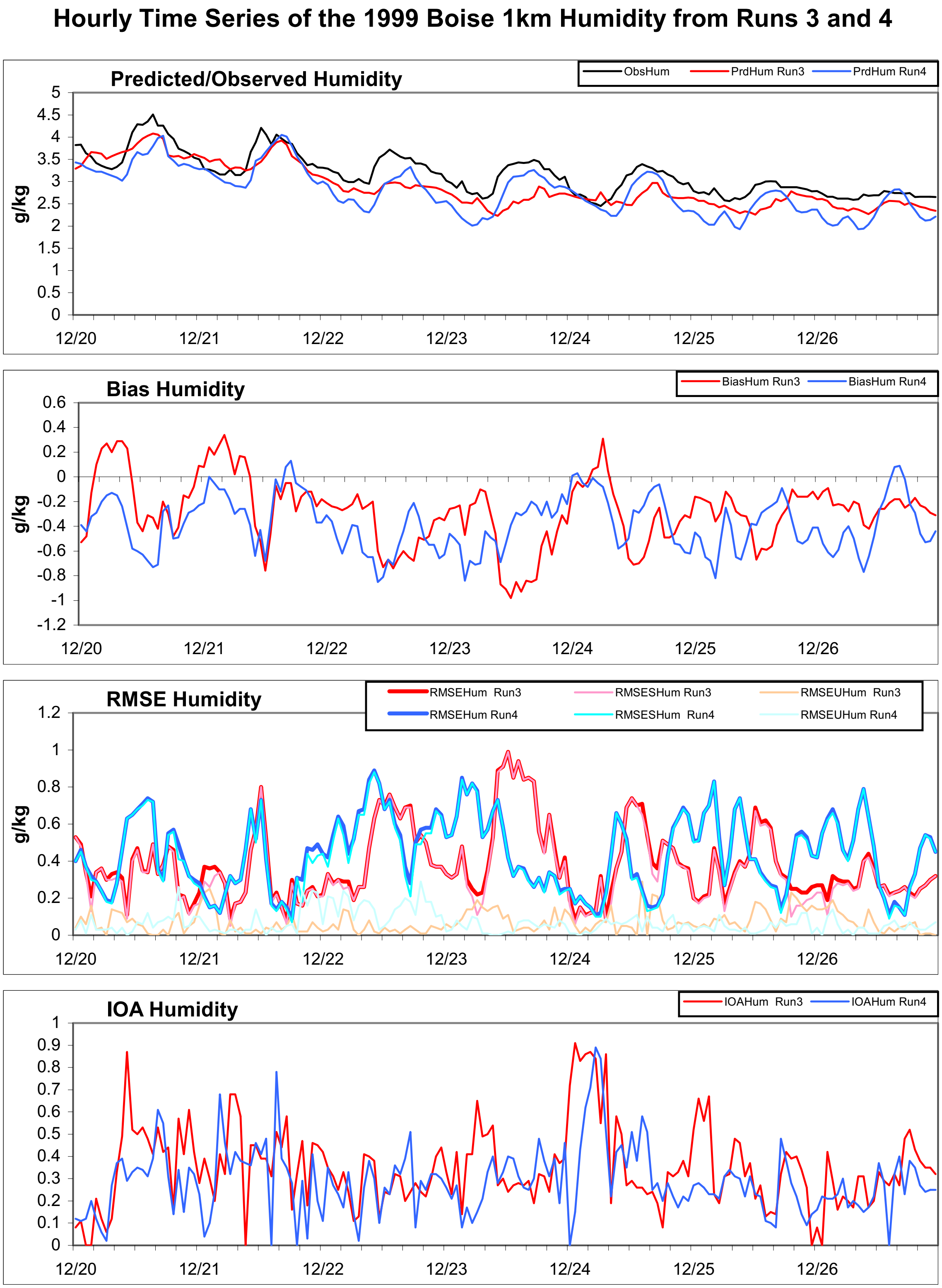

Figure 4-2c. Hourly composite surface humidity statistics from Runs 3 and 4 of the December 1999 simulation.

The composite observed surface temperatures showed a cooling trend and a diurnal range that decreased with each successive day. On the last two days of simulation, the observed temperatures remained within 1 degree of 268 K. Run 3 began with a diurnal range that was significantly less than observed. The diurnal range grew with each successive day as the daytime high temperatures remained nearly constant while the nighttime temperatures dropped. The afternoon temperature bias was –8 K on the second day of the simulation and rose to +5 K on the last day. Nighttime temperatures were within 2K of the observed on all dates. Run 4 simulated the cooling trend correctly, but every hour was cooler than the observed for the first four days. Nighttime temperatures were typically 2 K cooler and daytime peaks were 4 to 6 K less than observed. On December 25 and 26, Run 4 simulated an 8 K and 9 K temperature range, respectively, resulting in daytime highs being a few degrees too warm and nighttime lows being too cool.

Almost all hours of the composite humidity time series were under predicted in both MM5 runs. The greatest bias was –1.0 g/kg on December 23 from Run 3 and –0.8 g/kg on December 22 from Run 4. The observed humidity was greater in the afternoon than at night, and the moisture content gradually decreased with each successive day until it remained nearly constant on the last two days of simulation. Both runs predicted a similar trend. Run 4 diurnal range resembled the observed better on the first four days; Run 3 had a smaller range than Run 4 on all seven days, but fit the observed better on the last two days.

4.3.2 Daily Statistics

Daily statistics for each of the three sites and their composite were computed to evaluate the model performance of winds, temperature, and humidity of both Runs 3 and 4. These statistics are compared to benchmark values, shown in Table 4-1.

<u>Wind Speed</u>

Figure 4-3a displays bar charts of each day's composite mean wind statistics from both runs. The Run 4 daily mean predicted surface wind speed was greater than observed on six of the seven days. In Run 3, five of the seven days were within the wind speed bias benchmark of ±0.50 m/s; in Run 4 just four days met the benchmark. All days that exceeded this goal were over estimated. The worst performance took place on December 26, when Run 3 bias of 1.1 m/s was significantly greater than the observed mean speed of 0.26 m/s. The episode-mean composite biases of 0.32 m/s and 0.43 m/s for Run 3 and Run 4, respectively, both met the benchmark. Boise Fairgrounds had the best performance as all days met the benchmark value in both runs.

The best performance took place on the two dates with the strongest observed winds, December 20 and 21. These were the only dates that met the wind speed IOA benchmark of 0.60 in both runs. Run 3 met this benchmark on two additional days on the dates with the next highest mean observed winds. Both met the total RMSE benchmark on all but one date – December 26 for Run 3 and December 24 for Run 4. The systematic and unsystematic RMSE were fairly balanced each day. The good performance during higher winds is typical of prognostic meteorological models, as they perform best when larger-scale forcings come into play.

Table 4-1a. Comparison of MM5 Run 3 daily statistics with statistical benchmarks.

Parameter	Benchmark	Boise Airport		Boise Fairgrounds		Caldwell		All Sites	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Wind Speed RMSE	2.0	1.0 – 2.6	1.6	0.5 – 1.1	0.8	1.2 – 4.4	2.0	1.0 – 2.7	1.61
Wind Speed Bias	±0.5	-0.8 – 1.6	0.5	-0.4 – 0.3	0.0	-0.5 – 2.2	0.5	-0.4 – 1.1	0.32
Wind Speed IOA	0.60	0.02 – 0.76	0.53	0.26 – 0.88	0.65	0.06 – 0.65	0.36	0.08 – 0.68	0.52
Wind Direction Gross Error	30	20 – 77	42	45 – 77	61	13 – 85	56	40 – 61	54
Wind Direction Bias	±10	-24 – 37	5	0 – 48	26	-40 – 37	-1	-11 – 32	14
Temperature Gross Error	2.0	1.3 – 3.1	2.2	1.4 – 3.3	2.4	1.1 – 3.4	2.6	1.3 – 3.3	2.4
Temperature Bias	±0.5	-2.9 – 1.7	-0.8	-2.9 – 0.9	-1.3	-3.3 – -0.3	-2.1	-3.0 – 0.8	-1.4
Temperature IOA	0.80	0.23 – 0.91	0.63	0.13 – 0.88	0.59	0.12 – 0.83	0.56	0.23 – 0.90	0.61
Humidity Gross Error	2.0	0.2 – 0.6	0.3	0.3 – 0.5	0.4	0.2 – 0.5	0.4	0.3 – 0.5	0.3
Humidity Bias	±1.0	-0.6 – 0.0	-0.2	-0.5 – -0.2	-0.3	-0.5 – -0.0	-0.3	-0.5 – -0.1	-0.3
Humidity IOA	0.60	0.22 – 0.72	0.51	0.20 – 0.70	0.47	0.32 – 0.72	0.51	0.37 – 0.66	0.52

Table 4-1b. Comparison of MM5 Run 4 daily statistics with statistical benchmarks.

		Boise Airport		Boise Fairgrounds		Caldwell		All Sites	
Parameter	Benchmark	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Wind Speed RMSE	2.0	1.0 – 1.9	1.4	0.6 – 1.2	0.8	1.5 – 2.9	2.1	1.1 – 2.1	1.51
Wind Speed Bias	±0.5	-0.4 – 0.9	0.4	-0.4 – 0.2	-0.1	-0.1 – 2.1	1.0	-0.1 – 0.9	0.43
Wind Speed IOA	0.60	0.02 – 0.90	0.56	0.43 – 0.97	0.64	0.08 – 0.46	0.27	0.25 – 0.80	0.51
Wind Direction Gross Error	30	14 – 96	41	53 – 81	66	33 – 93	59	40 – 75	55
Wind Direction Bias	±10	-96 – 45	-9	-36 – 37	9	-44 – 44	-3	-35 – 19	3
Temperature Gross Error	2.0	1.6 – 2.9	2.3	1.7 – 2.8	2.4	1.5 – 3.1	2.2	1.6 – 2.8	2.3
Temperature Bias	±0.5	-2.9 – -1.1	-1.9	-2.6 – -1.3	-2.0	-2.5 – -0.5	-1.8	-2.5 – -1.2	-1.9
Temperature IOA	0.80	0.28 – 0.88	0.71	0.13 – 0.88	0.66	0.11 – 0.89	0.66	0.22 – 0.87	0.68
Humidity Gross Error	2.0	0.2 – 0.5	0.3	0.4 – 0.8	0.6	0.3 – 0.5	0.4	0.3 – 0.5	0.4
Humidity Bias	±1.0	-0.5 – -0.1	-0.3	-0.8 – -0.3	-0.6	-0.5 – -0.2	-0.3	-0.5 – -0.2	-0.4
Humidity IOA	0.60	0.29 – 0.89	0.66	0.13 – 0.74	0.46	0.30 – 0.79	0.61	0.31 – 0.78	0.57

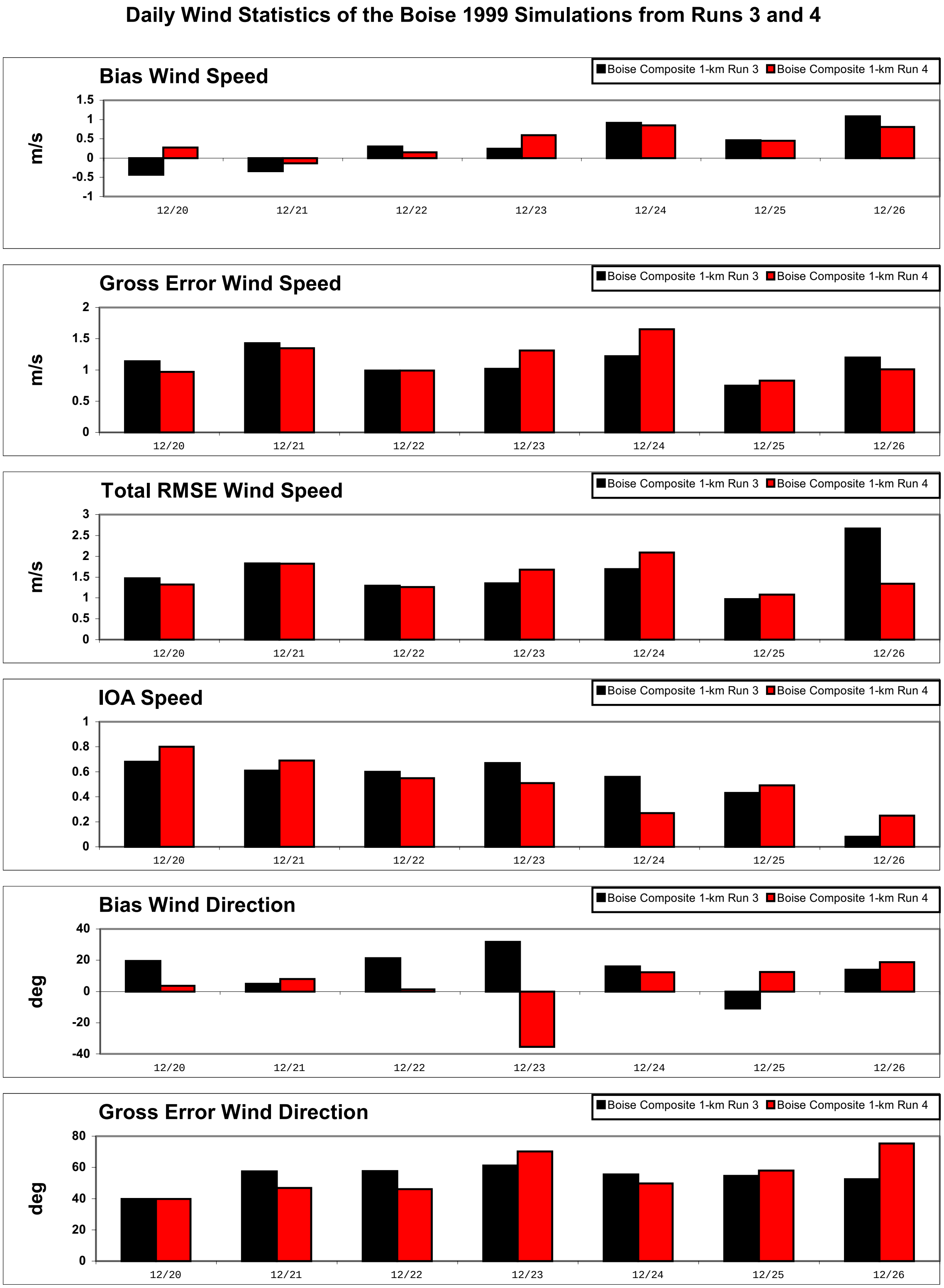

Figure 4-3a. Daily composite surface wind statistics from Runs 3 and 4 of the December 1999 simulation.

Daily Temperature Statistics of the Boise 1999 Simulations from Runs 3 and 4

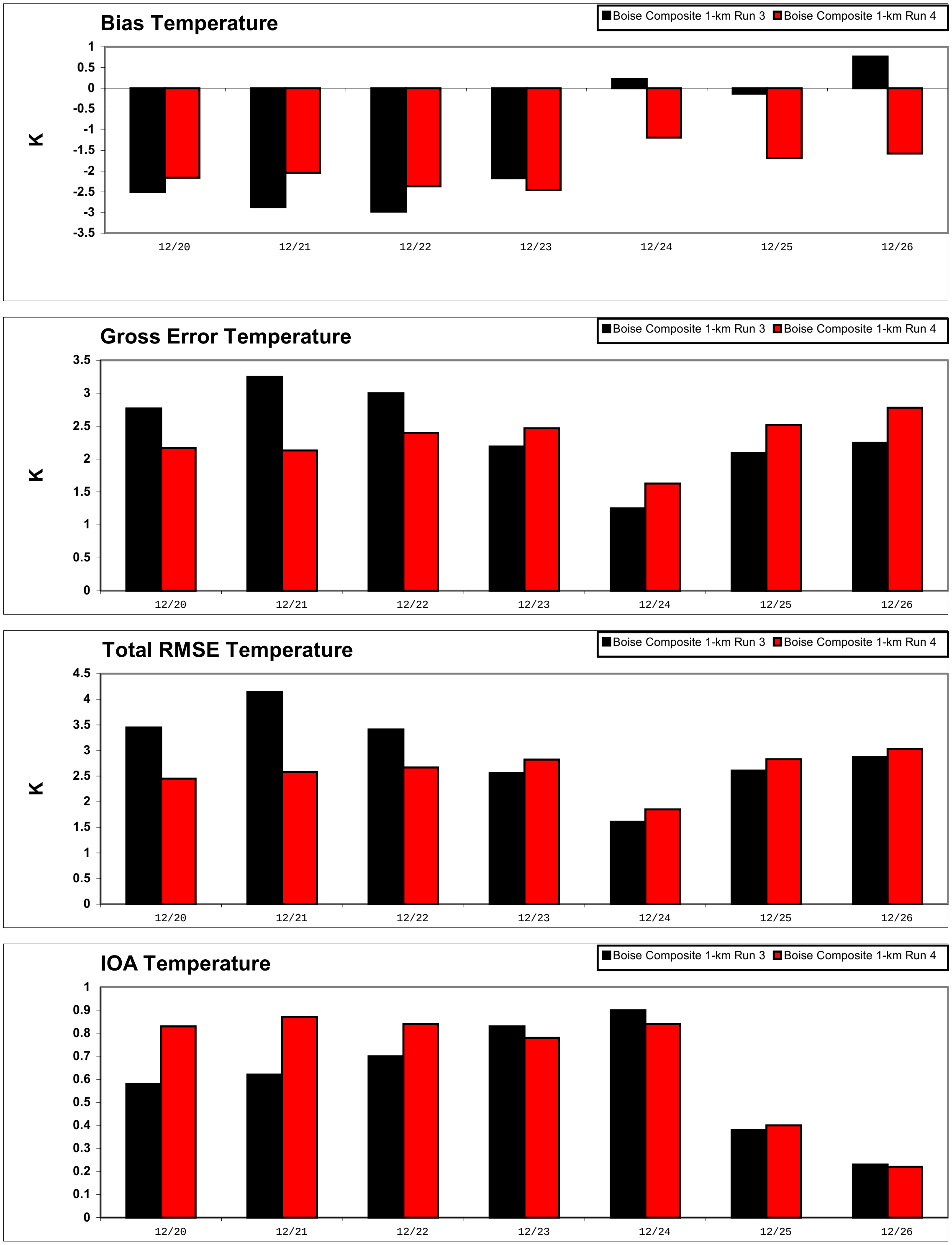

Figure 4-3b. Daily composite surface temperature statistics from Runs 3 and 4 of the December 1999 simulation.

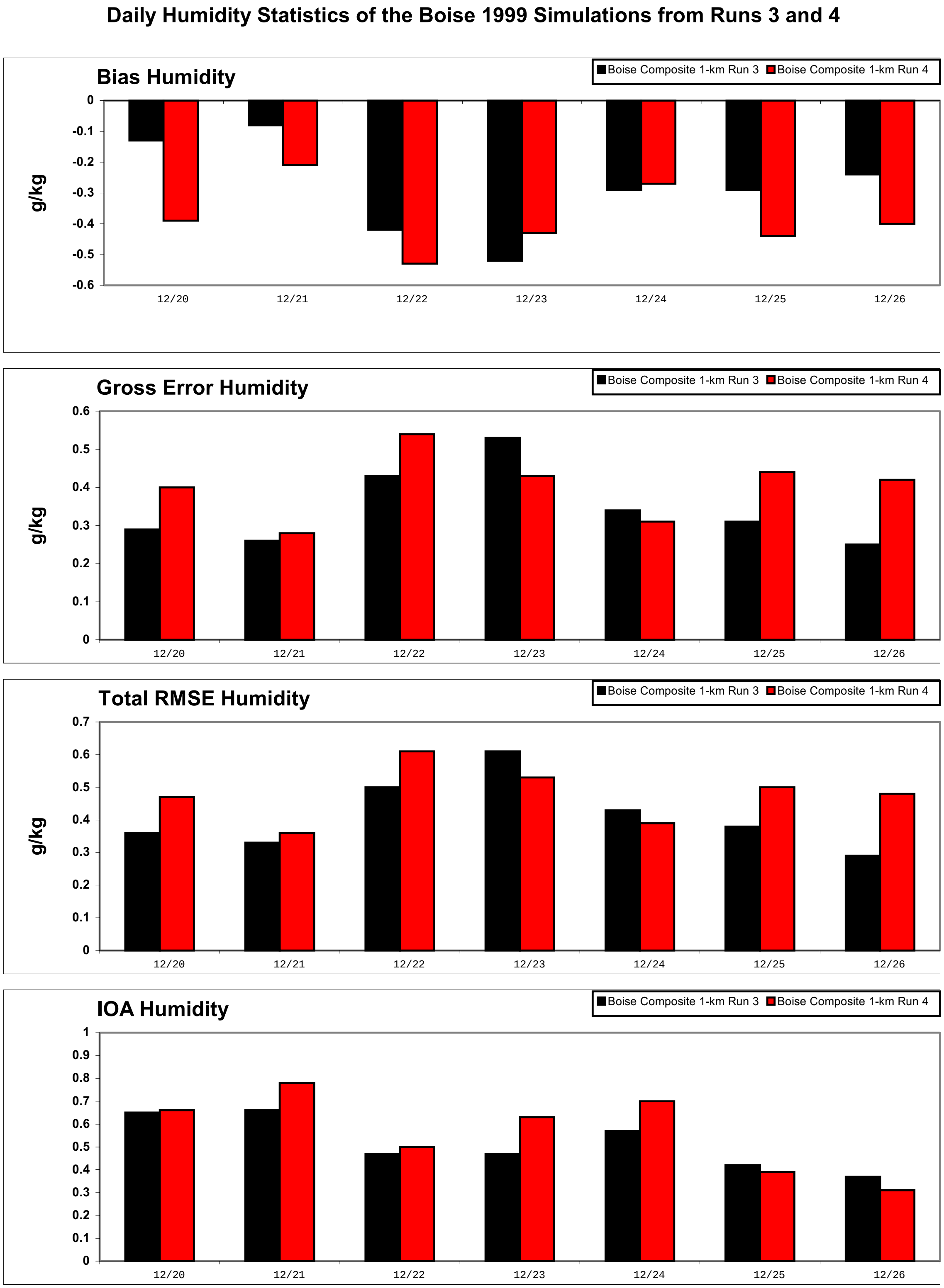

Figure 4-3c. Daily composite surface humidity statistics from Runs 3 and 4 of the December 1999 simulation.

Wind direction

The daily mean measured wind direction was westerly each day except December 23, when it was southerly. Both runs simulated the worst bias on this date; Run 3 was 32° and Run 4 was −35°. The best bias from Run 3 was 5 degrees on December 21, which was the only day within the ±10 degree modeling benchmark range. In Run 4, the first 3 dates all were within ±10 degrees. Bias on the last four days was higher, but the episode mean at each individual station and from the composite all met the bias benchmark in Run 4. None of the seven dates met the benchmark for wind direction gross error in either run, again because this benchmark is likely to be too stringent. Gross error was lowest on December 20 (40 degrees in both Run 3 and Run 4). The largest gross error is seen in Run 4 on December 26, the date with the lowest composite wind speed. Wind direction tends to be more variable when the wind speed is light, so larger errors would be expected on days with lighter winds.

Temperature

The daily mean observed surface temperatures decreased with each subsequent day. Run 4 replicated this trend well but simulated all temperatures less than the observed. Run 3 simulated a cooling trend on the first four days, when temperatures were also under predicted, before leveling off on the last three days, when the bias turned slightly positive. Figure 4-3b shows the daily composite temperature statistics. On the first four simulation days, temperature bias from both runs exceeded -2.0 K and the RMSE was dominated by the systematic component, as hourly temperatures were consistently cooler than observed. In Run 3, the gross error was largest on December 21. In Run 4, it was greatest at the end of the simulation on December 25 and 26, when the observations were nearly constant. On those two dates, the unsystematic component of the RMSE dominated. The best performance in surface temperature from both runs occurred on December 24, the transition date when the diurnal temperature pattern shifted from a typical cycle to near isothermal; bias and gross error were 0.2 K and 1.3K, respectively, in Run 3. This was the only date when the gross error met the temperature benchmark in both runs. Run 3 met the bias goal on two days; no days in Run 4 achieved it. The IOA benchmark of 0.80 was achieved two days in Run 3 and four days in Run 4.

Humidity

The daily mean observed surface humidity lowered with each day, dropping from 3.8 g/kg on December 20 to 2.7 g/kg on December 26. Moisture content from both runs also fell with each day, except for a small rise in Run 3 on December 24. Humidity was under predicted each day in both runs. Figure 4-3c displays bar charts of the daily moisture statistics. The worst bias and error from both runs were -0.5 g/kg and 0.5 g/kg, respectively. These statistics beat the humidity benchmarks, which were not designed for such a cool and dry scenario. The total RMSE was dominated by the systematic component on most days. The humidity IOA met the benchmark on two of the seven days in Run 3 and four days in Run 4. In summary, it is difficult from the mixed statistical messages to gauge in any definitive way if Run 4 is indeed performing better than Run 3. There are clearly signs that Run 4 performs better for certain variables (e.g., temperature early in the period), and some statistics (usually IOA). But Run 3 also shows some superior statistical performance over Run 4 (see Table 4-1). Both runs indicate similar performance problems and achievements. Thus, we conclude that the two runs are more similar than different, and that the improvements expected with the configuration of Run 4 (to match Run 11 for January 1991) were realized in only a few limited areas.

4.4 GRAPHICAL ANALYSIS

Vertical profiles of the Run 4 predicted and observed wind speed and direction, temperature, and humidity over Boise are available for viewing in Appendix B. Since the Boise upper air observations were heavily nudged in Run 4, the predicted soundings over Boise were very similar to the observed. Soundings are plotted every 12 hours beginning on December 20 at 0500 LST (1200 GMT).

Appendix D displays plots of the horizontal surface layer winds and temperature fields on the 1-km grid. One plot per episode day is shown at local noon. Plots of cloud/fog cover are not shown as MM5 did not generate any significant cloud cover at noon during the period.

4.5 QUALITATIVE ANALYSIS

Gridded fields of sea level pressure and surface wind, temperature, and mixing ratio were examined every 12 hours to validate the synoptic scale features predicted in Run 4. Results from the 27-km domain were compared to the analyzed surface weather maps of the U.S. (available online at http://weather.unisys.com/archive/sfc_map/9912/). Plots of the 1-km domain were used to examine mesoscale impacts from the complex topography.

December 20

On the first morning of simulation, the 0500 MST (1200Z) weather map depicted a 1036+ mb high pressure system building off the coast of British Columbia. Winds were northwesterly at 5-10 kts at most stations surrounding Boise except at Pocatello, where 15 kt southwesterlies were observed. Temperatures were mostly in the lower 30s.

The simulated sea level pressure field was difficult to analyze because the extrapolation to sea level generated local highs and lows that appeared to be influenced by the terrain height. The higher elevations, including the Salmon River Mountains in central Idaho and Pioneer Mountains in southwestern Montana, had lower sea level pressure while areas with lower terrain, including Boise and the Washington/Oregon borderline, were simulated with higher pressure. Values at the lower elevations are used to assess sea level pressure since the distance to extrapolate is less. During this hour, the simulated pressure field looked reasonable with higher pressure in the northwest and values within 1 mb of observed over Boise. The wind field looked very reasonable as northwest winds dominated over Idaho. MM5 simulated stronger winds over higher terrain, with the wind flowing around the Salmon River Mountains and channeling inside the Snake River Plain from west to east. Light west-northwesterlies at Boise agreed with the observed while the 10 kt westerlies near Pocatello were weaker than observed. The northerly component seemed too strong over Pocatello and northeastern Nevada. Morning temperatures near 30°F in southern Idaho were well predicted. Temperature and mixing ratio were much lower over the higher terrain, as would be expected.

At 1700 MST, a 1038 mb high was observed off the coast of Washington. Winds were variable at 5 kts. Sites in the northern half of the 27-km grid were overcast with reports of snow while the southern half was clear. Temperatures were in the mid 30s to lower 40s. The sea level pressure over Boise was 2 mb higher than observed. Topographic influences remained evident in the pressure, temperature, and mixing ratio field. The northerly component continued to be too strong over the southeast corner of the coarse grid. MM5 correctly simulated light northwest winds near Boise but over predicted the speed of the west-southwest wind over Pocatello. Temperatures were simulated well with afternoon temperatures in the mid 30s over Pocatello and near 40°F over Boise.

December 21, 1999

At 0500 MST, the 1036+ mb surface high moved onshore with its center over British Columbia. A 12 mb pressure gradient existed between the northern tip and southeast corner of Idaho. The northern half of the 27-km domain remained overcast with north winds. The southern half reported light south winds with clear skies, except at Pocatello, where snow was falling due to its proximity to a surface trough developing over Salt Lake City. Temperatures were in the lower 30s in the cloud-covered areas and mid 20s at the clear sites.

MM5 correctly simulated a stronger pressure gradient across Idaho. Pressure fell over northwestern Utah, corresponding well with the observed surface trough near Salt Lake. The model failed to simulate any precipitation or wind converging into the lower pressure. Winds channeling inside the Snake River Plain were weaker compared to the previous day, agreeing with the observations. Northwest winds continued to dominate in the 27-km domain as the model failed to simulate a southerly component over Boise and Pocatello. The 1-km domain did show south winds near Boise. The morning temperature field agreed well with observations in southern Idaho. Mixing ratios were greater in the extreme north and over Salt Lake, corresponding well with the cloudy areas.

No surface weather map was available at 1700 MST on this day.

MM5 predicted light winds over Washington and northern Oregon, near the center of the high. Winds were northwesterly in Montana and Idaho and northerly in Nevada and Utah as wind flowed around the high. The 10 kt northwest wind predicted over Boise fit well with the stronger breezes observed during the afternoon. Boise was one of the warmest locations simulated.

December 22

High pressure stretched from Washington to Colorado with a 1039 mb peak over northern Idaho at 0500 MST. Pressure gradients across Idaho were weak. Winds were mostly calm in the north, and 5 to 10 kts in the south. Temperatures were near 30°F in cities reporting clouds, and mid 20s or cooler in cities that were clear.

High pressure seemed to build over the area too quickly in the simulation. MM5 simulated a 1038 mb maximum near Boise when the observed was 1033 mb. Light and variable winds were simulated over Boise, and a 10 kt southwest wind over Pocatello matched the observation. The wind speed was slightly too high in the north. Surface temperatures looked

good as the model simulated mid 20s in southern Idaho to single digits in Nevada. Pocatello was about 5°F cooler than observed because the model did not simulate enough moisture over the region.
In the afternoon (1700 MST), skies were clear at most meteorological stations with variable 5 kt winds. Boise winds were northwesterly while Pocatello continued to be southwesterly. High pressure continued to dominate the state with temperatures in the 30s.

MM5 strengthened the surface high too quickly. MM5 simulated a 1043 mb high near Boise – 7 mb greater than the observed – with strong divergence around the high. The wind channeled along the valley floor, matching the northwesterlies at Boise that flowed around to Pocatello from the southwest. Winds were weaker on this afternoon compared to the previous afternoon. The temperature field was simulated well as the model predicted Boise warmer than its two lateral stations – Burns to its west and Pocatello to its east. The latter station was about 2°F too cool.

December 23

In the morning (0500 MST), the northwest-to-southeast oriented high pressure system intensified to 1046 mb over southwestern Montana. Most stations were calm except Boise, which reported a 5 kt southeasterly wind. Skies were overcast in the north and clear in the south.

The model under estimated the high over Montana, most likely due to the extrapolation from the high terrain, but it did simulate the high intensifying to 1047 mb near Boise. Isobars followed the terrain. Winds in the Snake River Plain reversed direction, flowing westward and then northwestward toward Boise, matching the observation. The 5 kt wind simulated over Pocatello was too strong. Temperatures showed Boise warmer than Burns and Pocatello, agreeing with the observed. Single digits were simulated well over northern Nevada.

By 1700 MST that afternoon, sea level pressure reached 1048 mb across the eastern Idaho border. Most sites reported either a gentle north wind or calm conditions. Skies were clear everywhere except Missoula. Temperatures were in the 30s with lower 40s in northern Nevada.

MM5 placed a high of 1050 mb near Boise with surface wind divergence. The surface wind field was well replicated, except in the extreme north, where they were too fast. On this afternoon, MM5 under predicted the temperatures in southern Idaho and eastern Oregon.

December 24

The highest pressure during the episode was observed at 0500 MST on this date. The 1050 mb high was centered over central Idaho. Most stations near Idaho reported overcast or hazy conditions with very light winds. Temperatures were in the teens and 20s.

The model simulated sea level pressure comparable to observations in magnitude, but located the high center further to the southwest, over lower terrain. Most of the winds were at 5 kts with a more turbulent pattern in the mountains in the 1 km domain. Down sloping winds appeared to be converging onto the Snake River Plain, creating a 5 kt southeast wind near

Boise that was too strong. The wind field was too strong over Nevada as well. In Salt Lake City, MM5 was nearly 10°F cooler than observed as a north wind was simulated instead of a south wind. Otherwise, the temperature field looked good with a local maximum near Boise. MM5 simulated abundant ground-level cloud water, assumed to be fog, over southeast Oregon and northern Nevada; this was not observed.

At 1700 MST, the 1046 mb surface high was centered directly over Boise. Pressure gradients and wind remained weak. In the north, skies remained overcast. In the south, all stations were clear except Boise, which was obscured in haze. Temperatures were in the upper 20s and 30s.

Pressure was over predicted by 4 mb over Boise. The wind field looked good with northeasterlies at Pocatello and northwesterlies at Boise. Temperatures were under estimated in Nevada and near Burns, possibly due to the fictitious fog simulated in the morning that reduced daytime heating. A light fog was simulated over Boise on this afternoon, fitting well with the observed haze.

December 25

At 0500 MST, a 1048 mb high was located over southwestern Montana with winds at 5 kts or less across the coarse grid. All stations in the north were overcast. Pocatello reported broken cloud coverage with haze while Boise was obscured by fog. Further to the west and south, away from the high's center, skies were clear.

MM5 simulated a 1052 mb high near Boise. Weak divergence was simulated around the high. In the 1-km domain, light northwest winds were simulated near Boise, matching the observations. In the coarse grid, where all the other observation sites were, wind direction was replicated poorly due to the lightness in the wind speed. The model simulated light amounts of ground-level cloud water over Boise on this morning; this was probably less fog than observed. Both temperature and moisture content were higher over Boise than Burns or Pocatello, leading to good spatial agreement in these fields.

Weather maps were not available at 1700 MST, so the surface map for 1400 MST was used. Pressure gradients across Idaho remained minimal. Calm conditions were observed at Burns, Pocatello, Boise, and Missoula. The former two sites were clear with temperatures near freezing; the latter two were overcast with temperatures in the mid 20s. The morning fog had not burned away in Boise.

Diverging surface winds were simulated beneath the 1049 mb high near Boise. The simulated wind field should have been a little weaker at Boise and Pocatello. The model correctly showed that Burns, not impeded by the fog, had a much larger diurnal temperature range compared to Boise, where fog was present. Temperatures were under predicted in northern Nevada.

December 26

Surface weather maps were unavailable at 0500 MST on this morning. Surface observations used for nudging indicated that the fog that first appeared late on December 24 continued to obscure the skies over Boise. Winds at most stations were calm.

The simulated wind speeds were too strong on this morning as areas of 10 kt winds were simulated over Idaho and Nevada. In the coarse grid, Boise winds were over predicted; in the 1-km grid, Boise winds were predicted well with nearly calm winds. No fog was simulated this hour in contrast to observed. Temperatures and moisture content were higher overnight at Boise compared to Burns and Pocatello.

At 1700 MST, the northern stations were calm while the southern stations, excluding Boise, were variable in direction at 5 kts. Like the previous afternoon, Boise was much colder than its neighboring sites because it was obscured in fog. A 1046 mb high continued to exist over western Montana.

MM5 simulated a 1047 mb high near Boise on this afternoon. The northerly component of the wind field seemed a little too strong as a north wind was simulated over Pocatello when it should have been south southwesterly. Wind speeds were over predicted at Boise. The model simulated fog over the focus area, agreeing with the observed, but probably not at the correct intensity. Temperatures at Boise were warmer than observed, possibly due to the lack of morning fog. Its diurnal range was smaller than its neighboring sites, but still much larger than observed.

4.6 SUMMARY

MM5 versions 3.4 and 3.5 were used to simulate a high PM_{10} episode that took place in December, 1999. The model configuration in the final Run 4 was based on the 1991 simulation that yielded the best results for that episode. A four-grid, two-way nesting simulation was conducted with 27, 9, 3, and 1-km grids. The model simulated the large-scale features well as it predicted a 1050 mb high moving over Idaho, with temperatures, wind speeds, and humidity all decreasing over time. Winds were simulated well on the first few days of simulation but were over predicted on the last two days. Temperature and humidity were slightly under predicted during most of the simulation with the best performance also at the beginning of the simulation. The winds were stronger than observed winds and humidity was under prediction on the last two days of simulation, probably preventing fog from lingering over Boise over the duration of both days.

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APPENDIX A

COMPARISON OF MM5 RESULTS (RUN 11) AGAINST TWICE-DAILY RAWINDSONDE SOUNDINGS FOR THE JANUARY 1-10, 1991 EPISODE

January 1-10, 1991: Boise, Idaho 12-hourly Soundings

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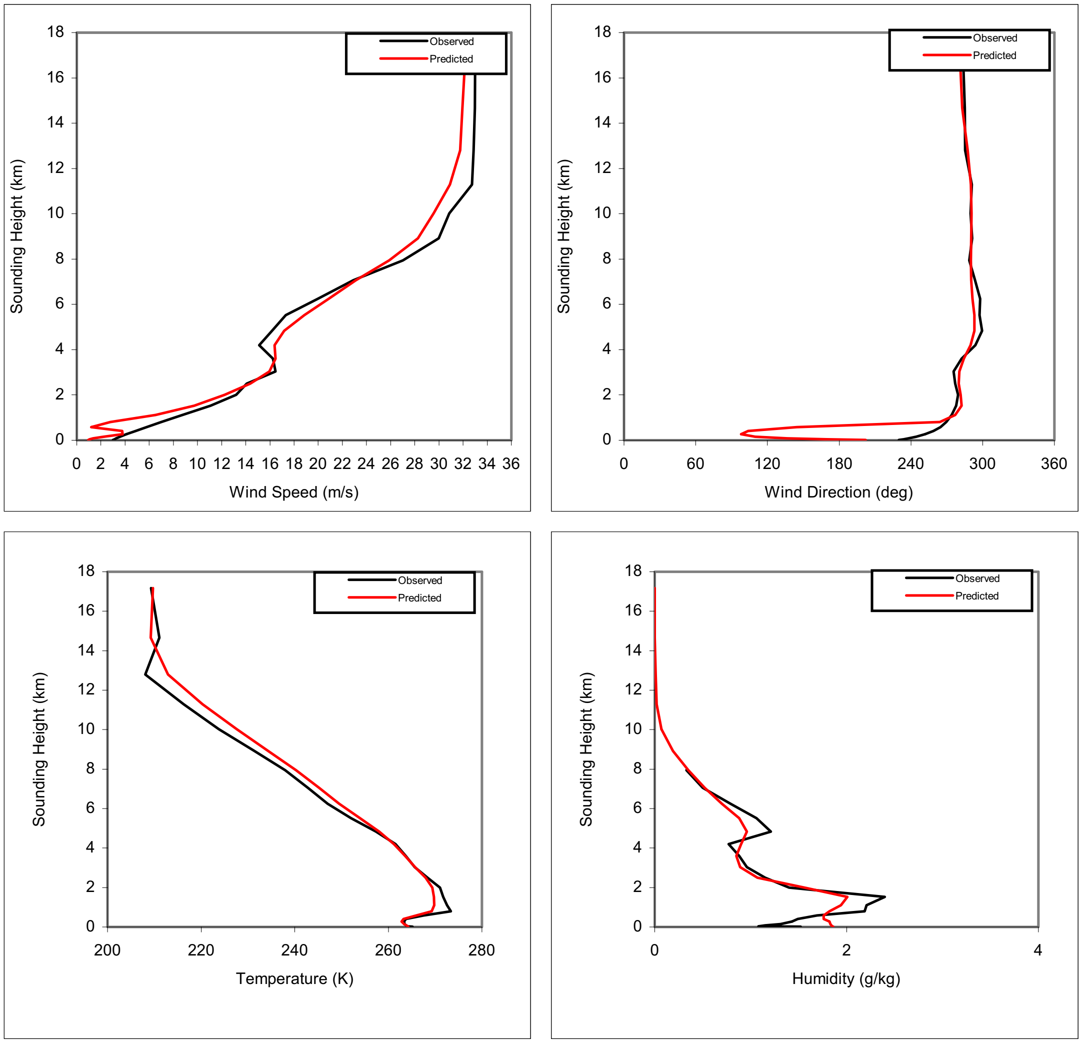

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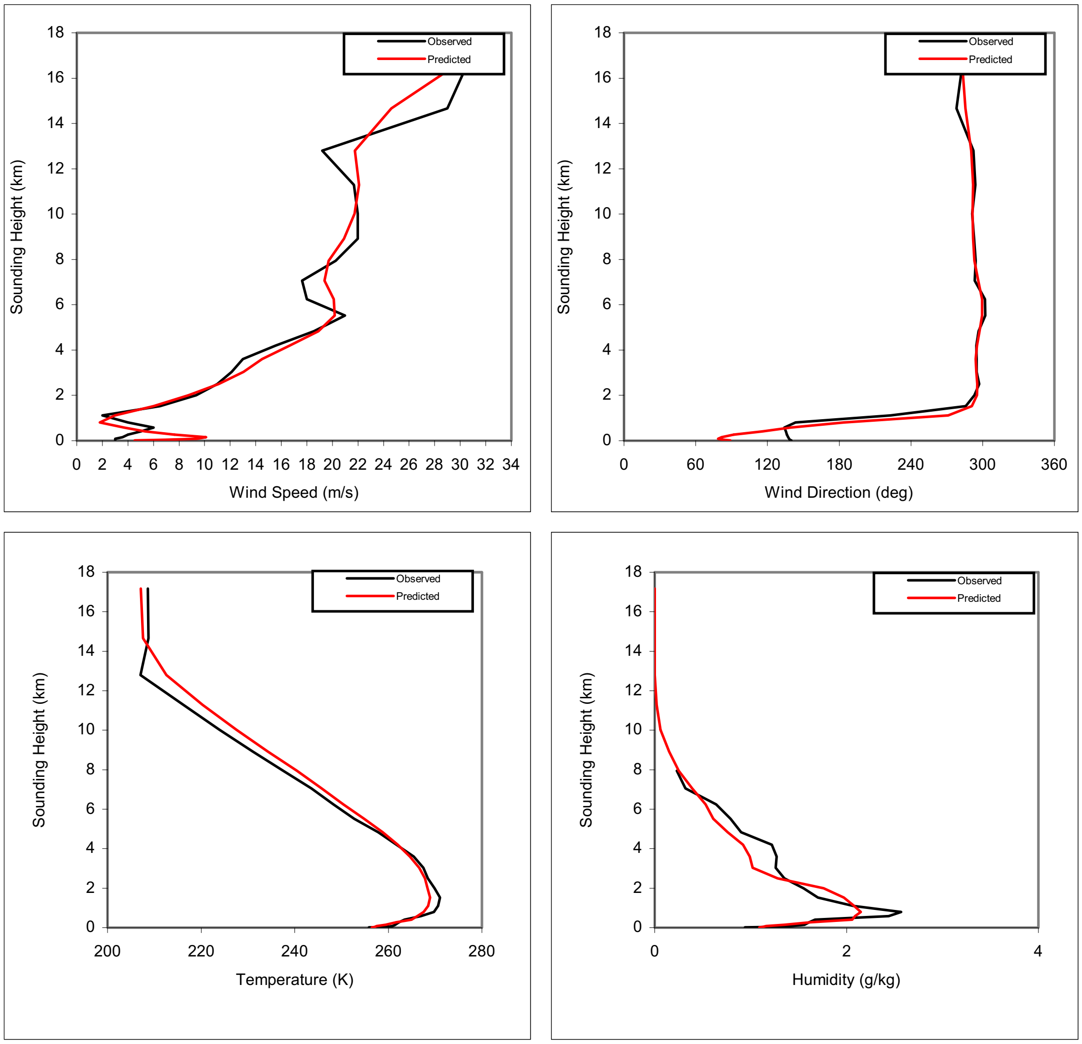

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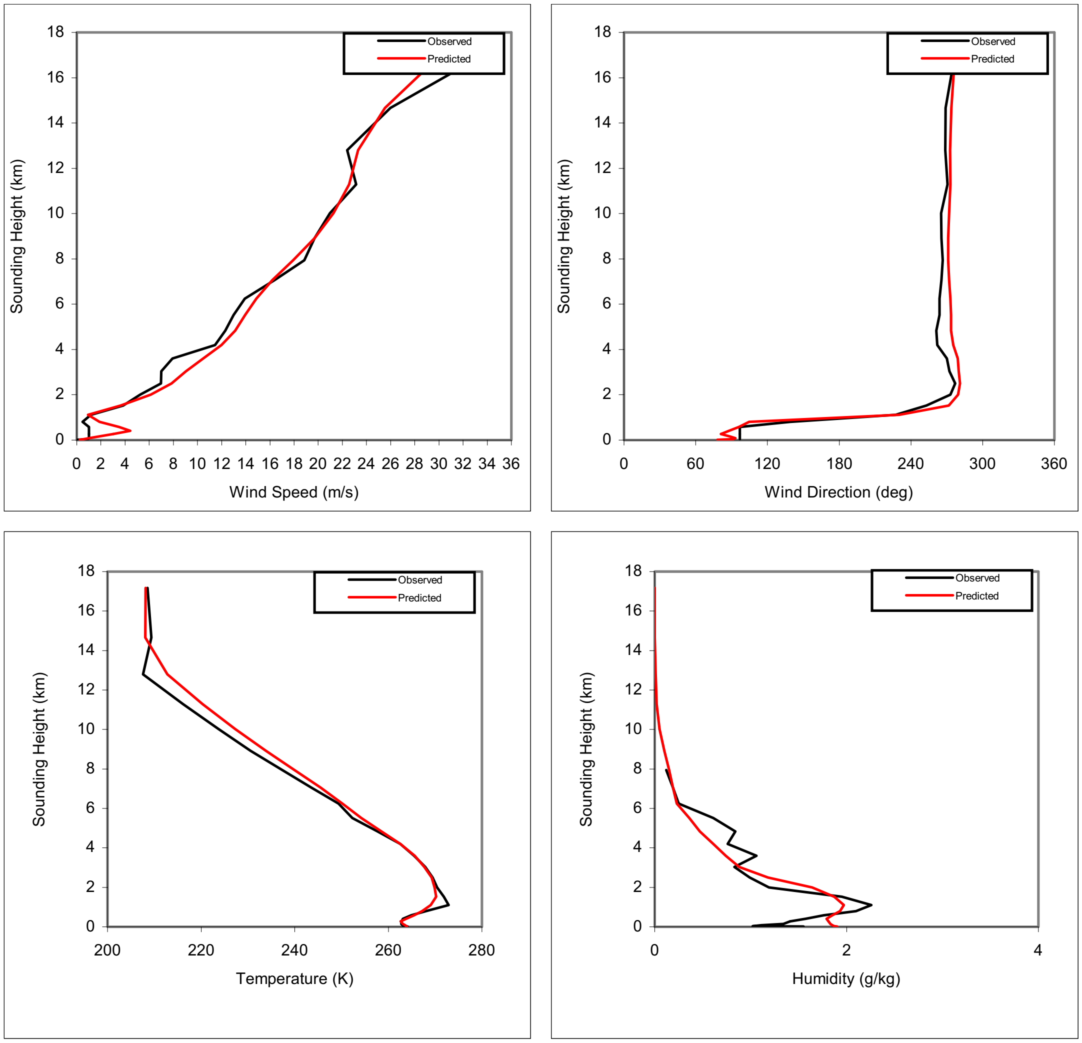

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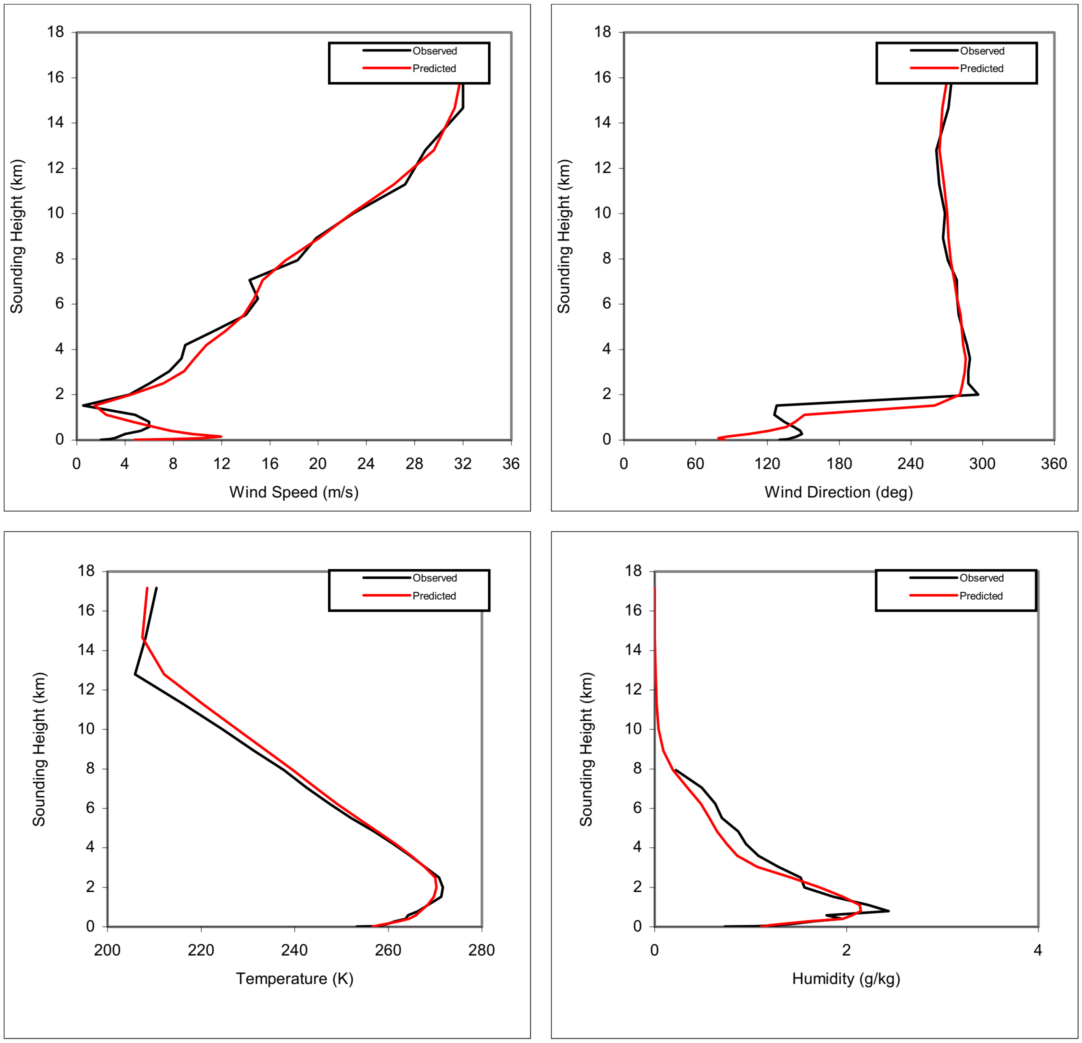

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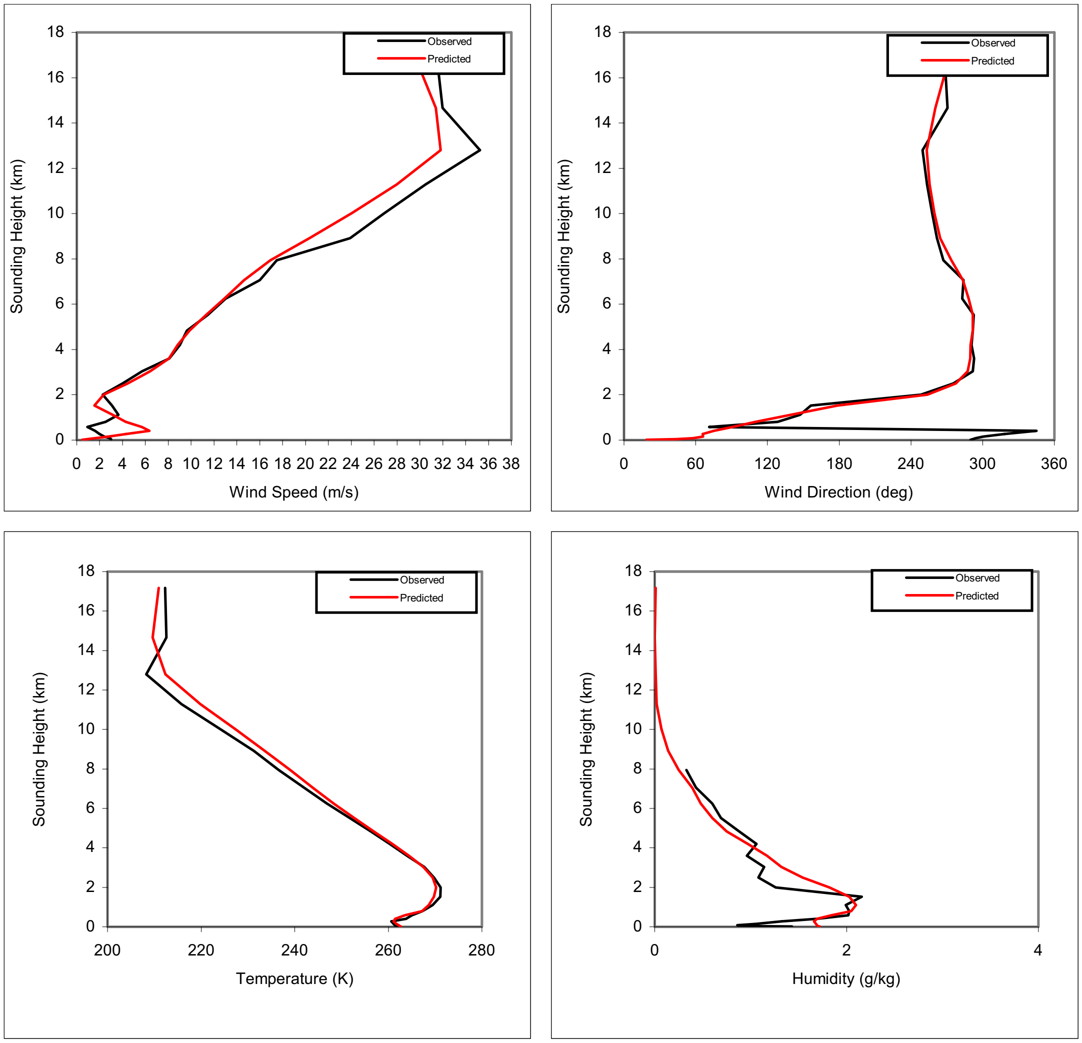
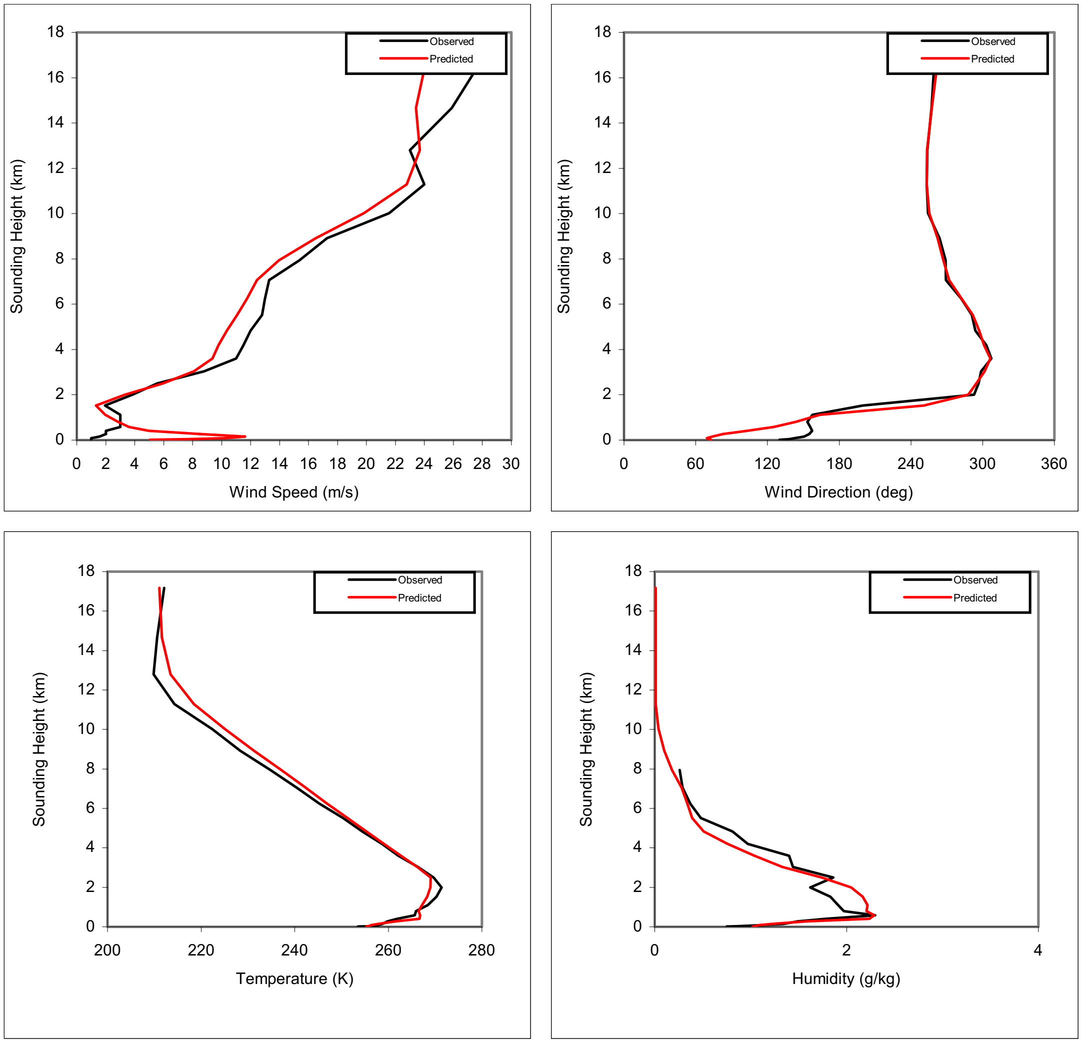


UP72681 Boise 1991010404 (run11)



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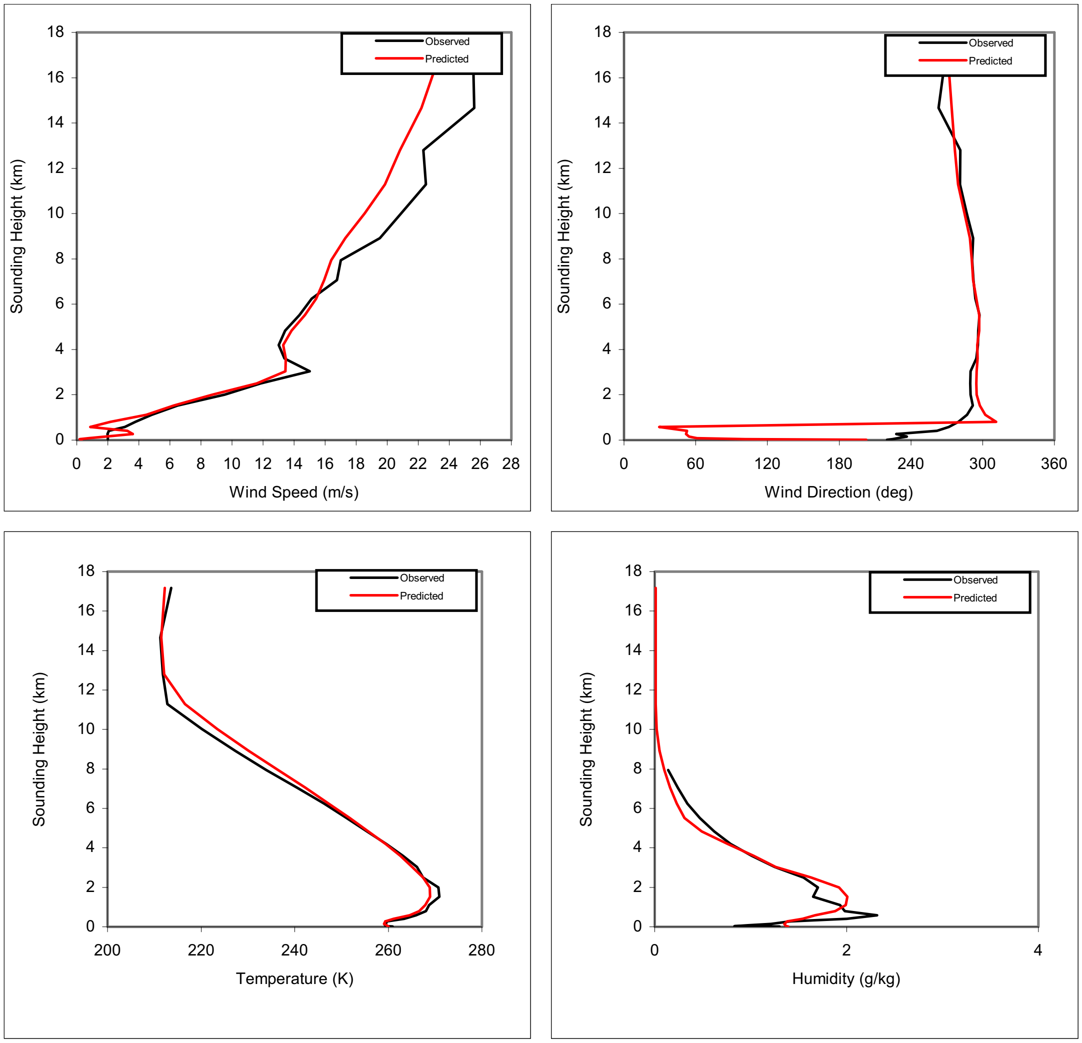

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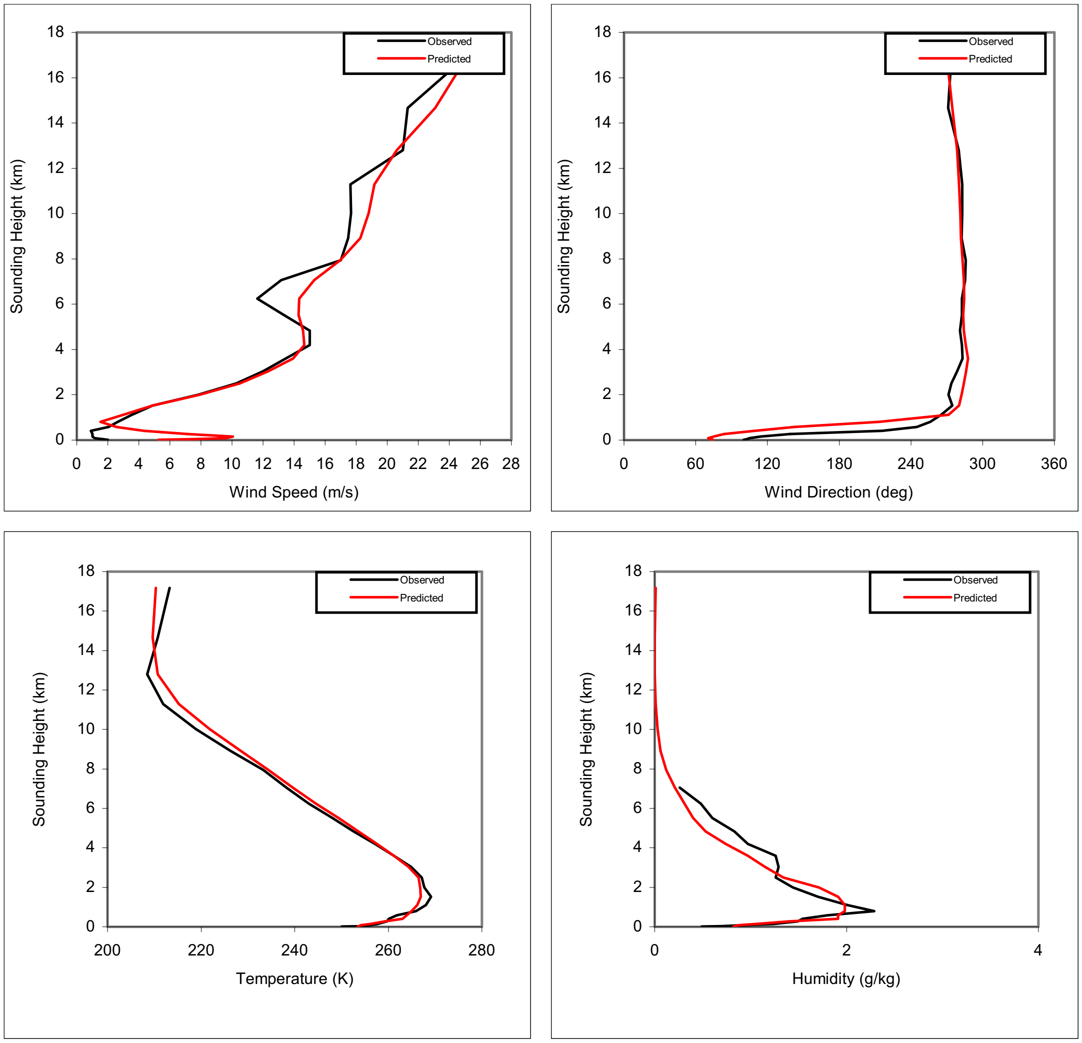

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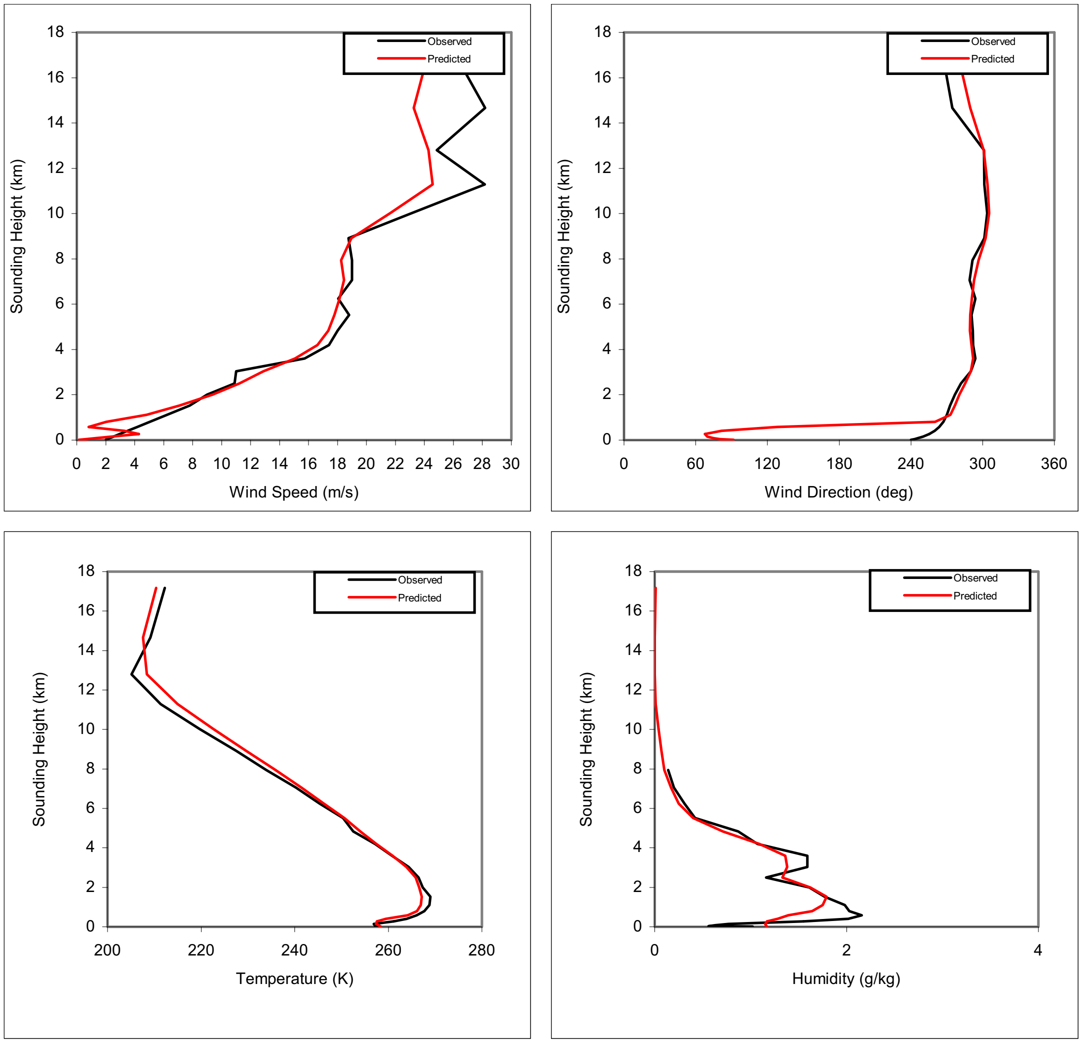

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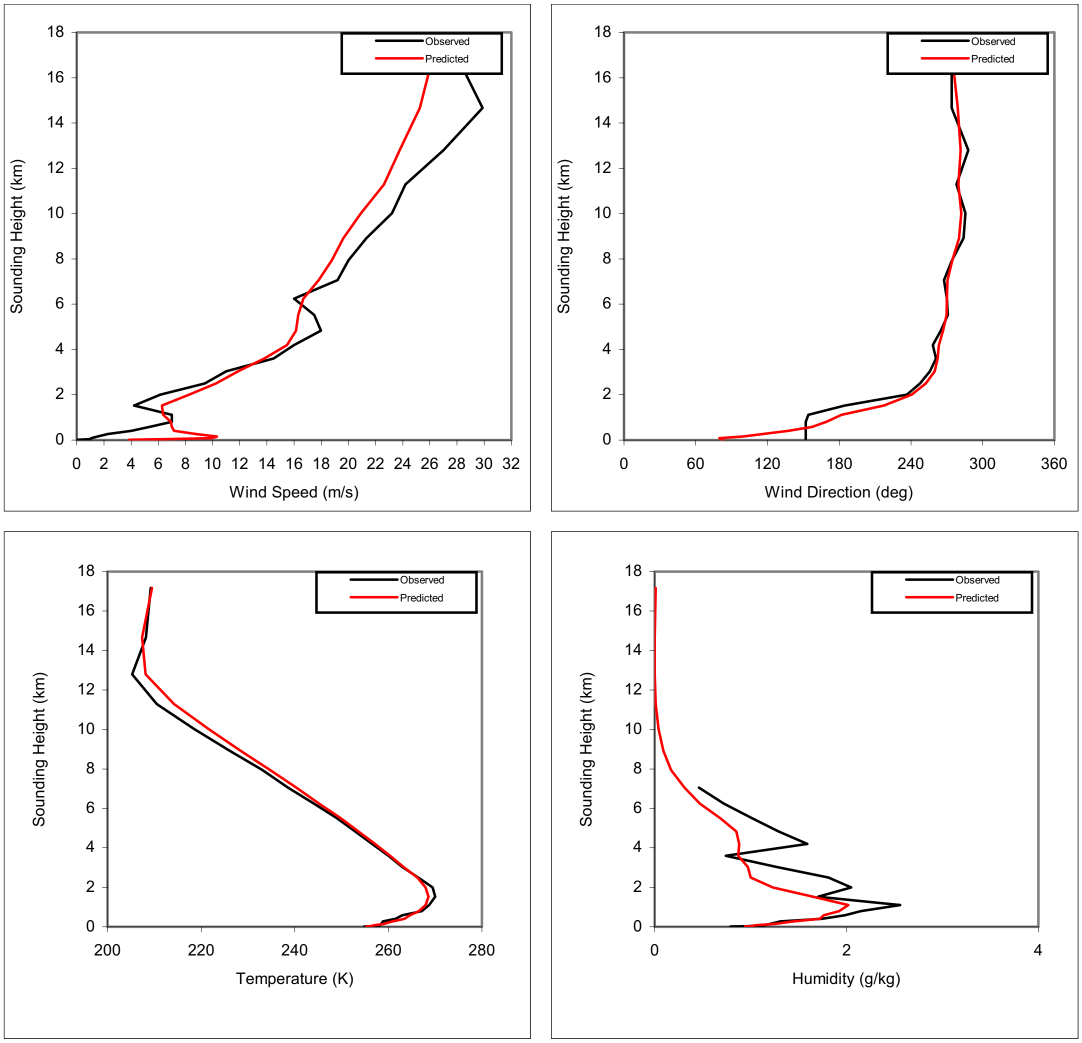

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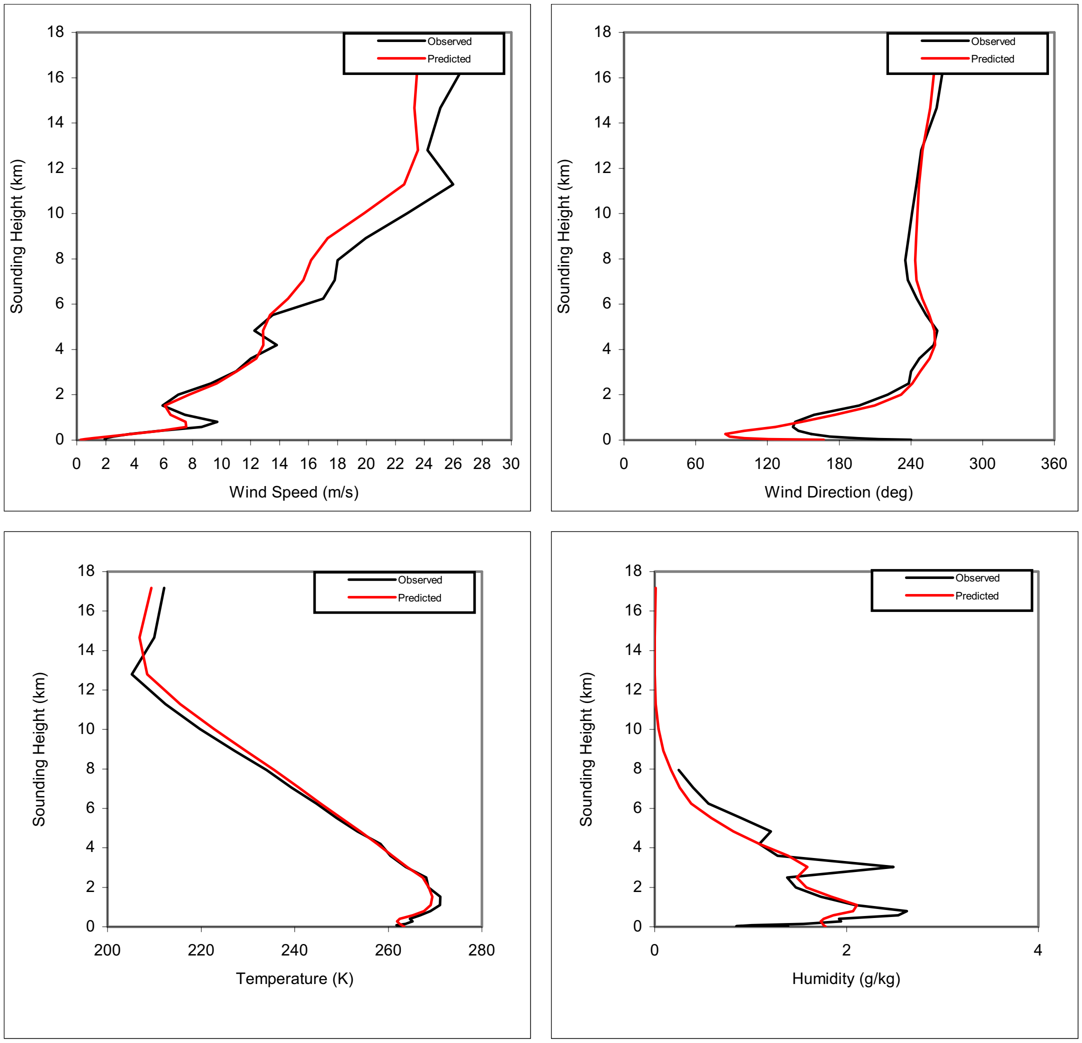

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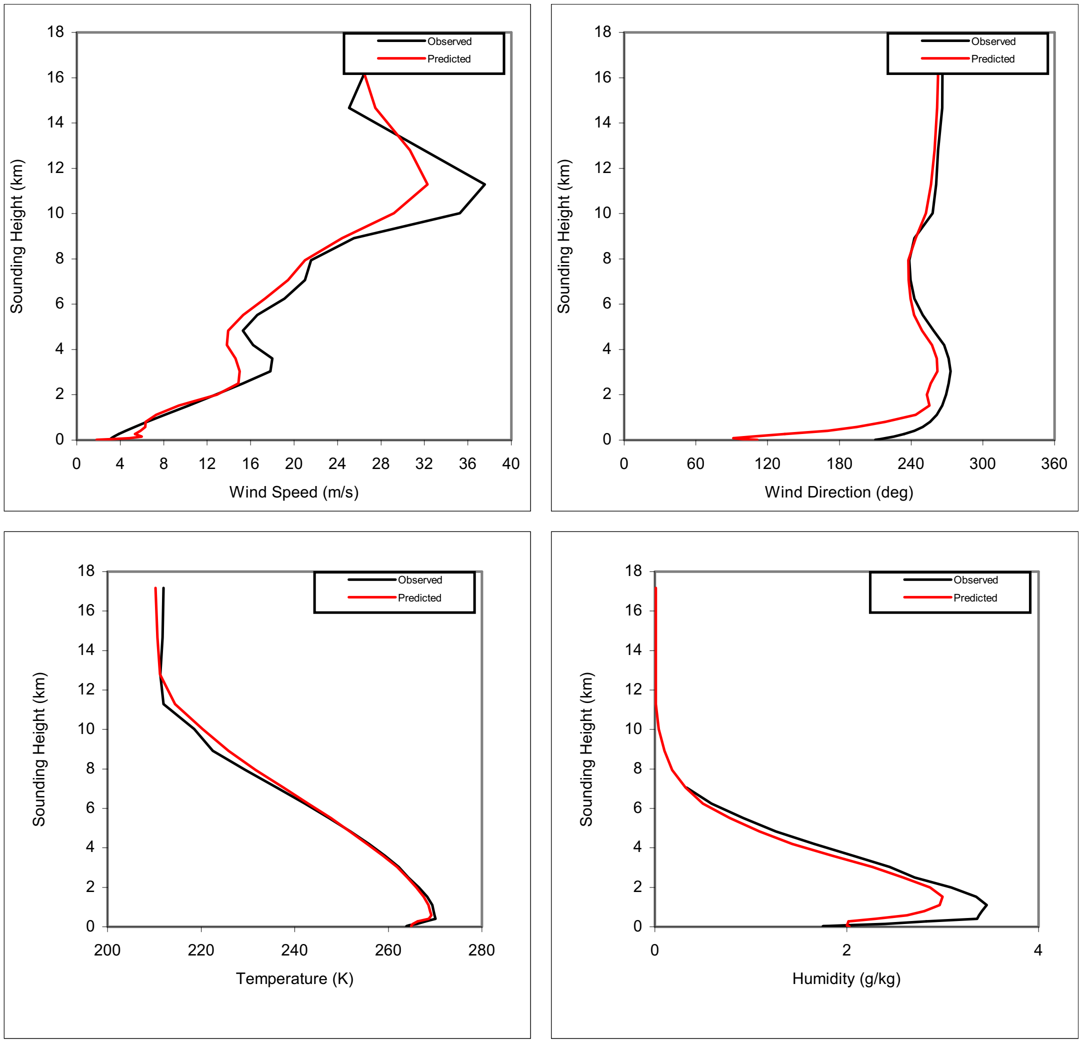

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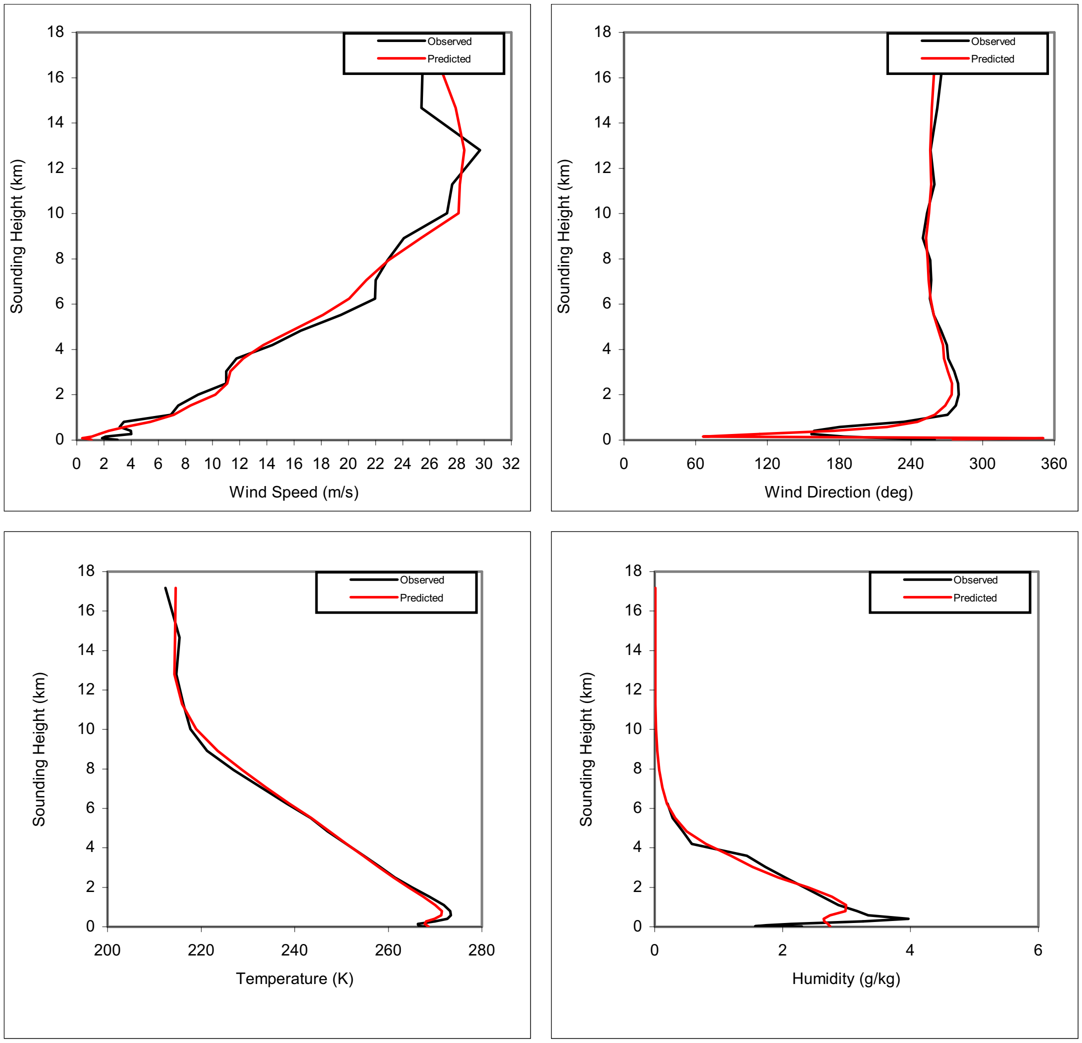

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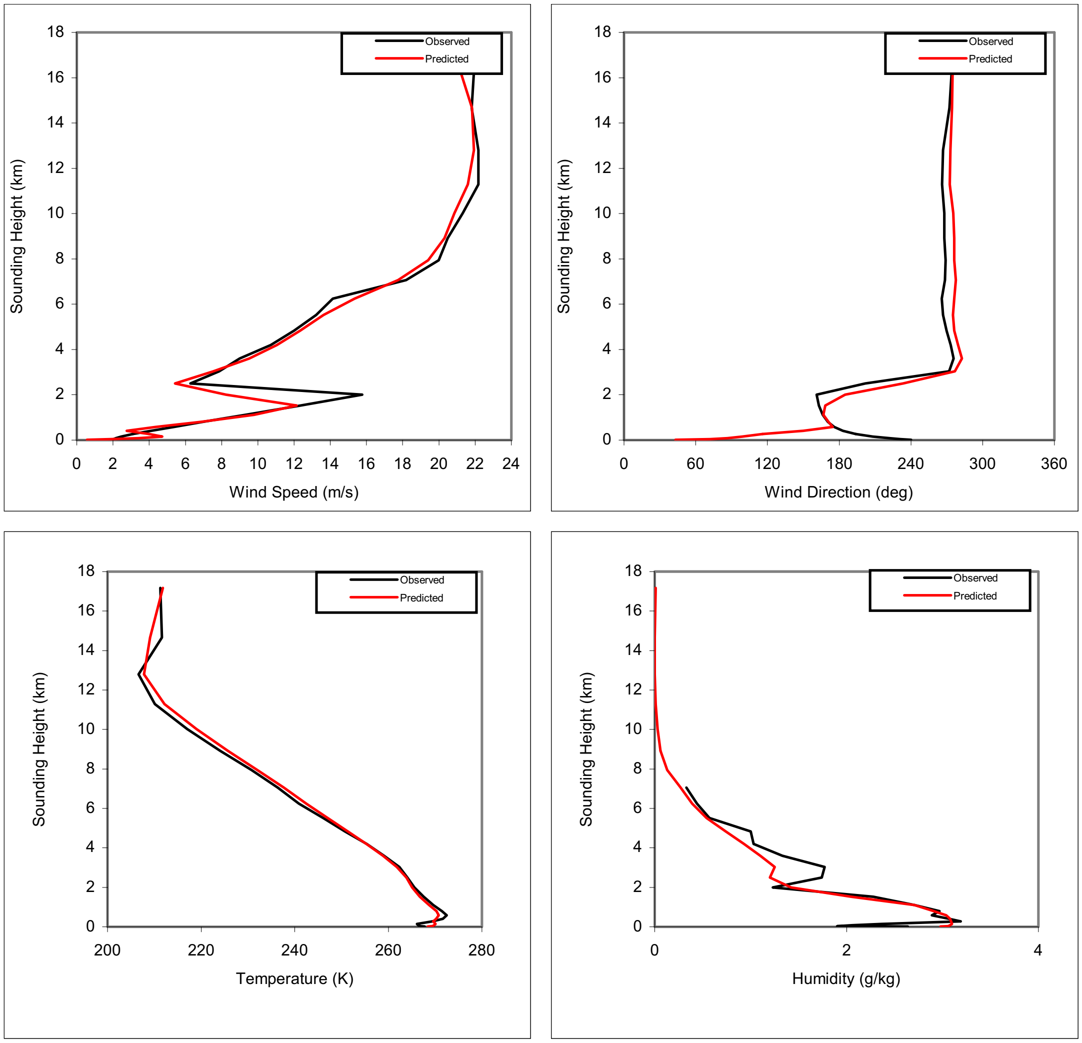

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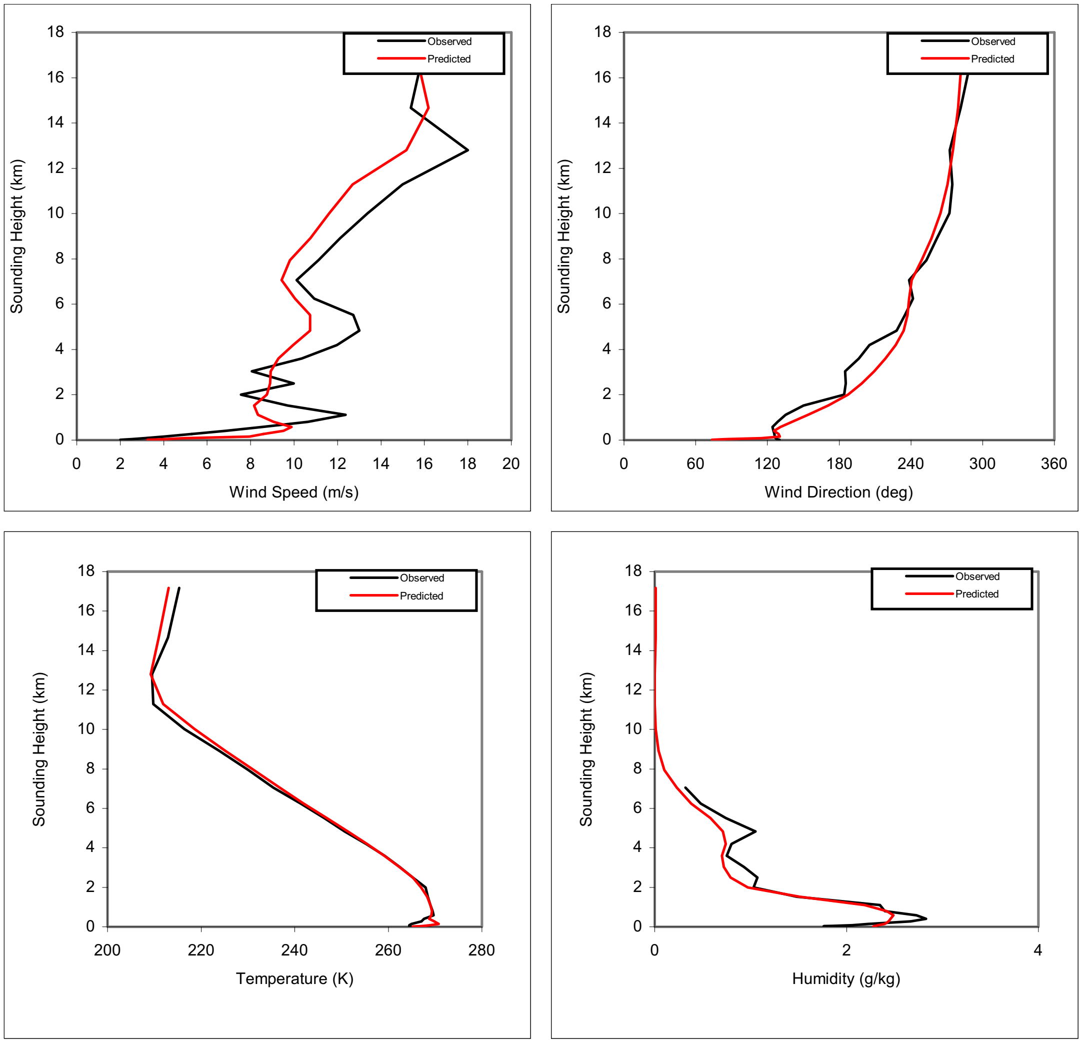

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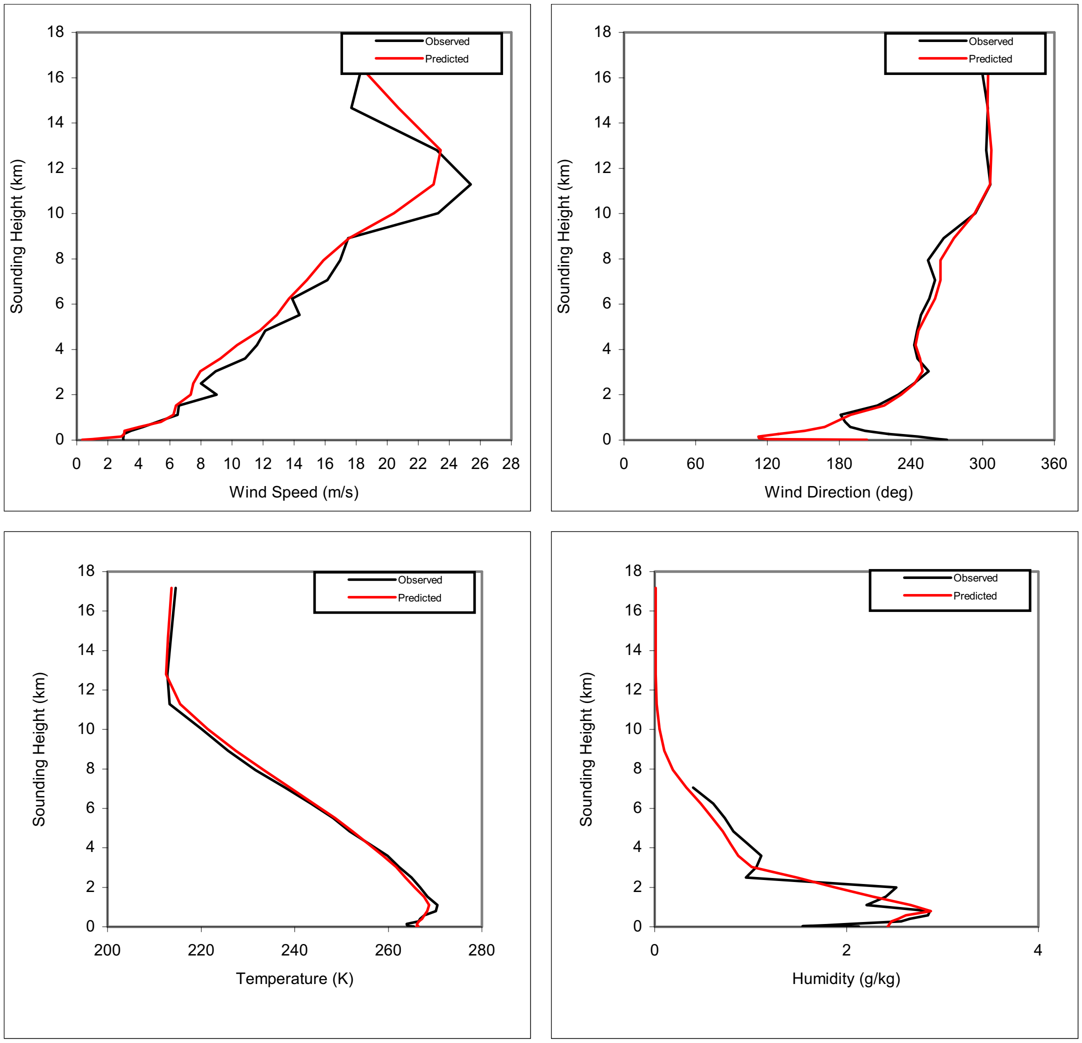

APPENDIX B

COMPARISON OF MM5 RESULTS (RUN 4) AGAINST TWICE-DAILY RAWINDSONDE SOUNDINGS FOR THE DECEMBER 20-26, 1999 EPISODE

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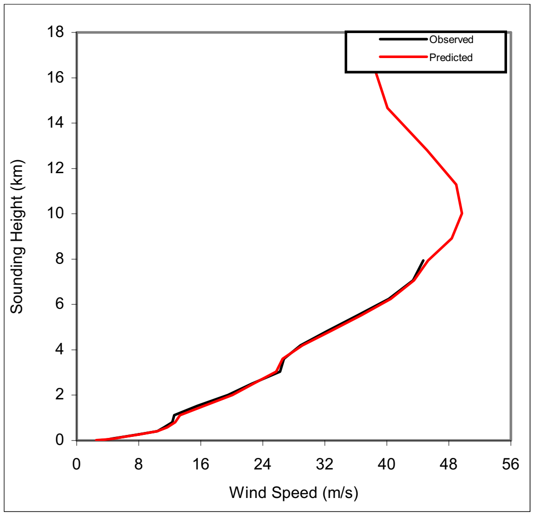
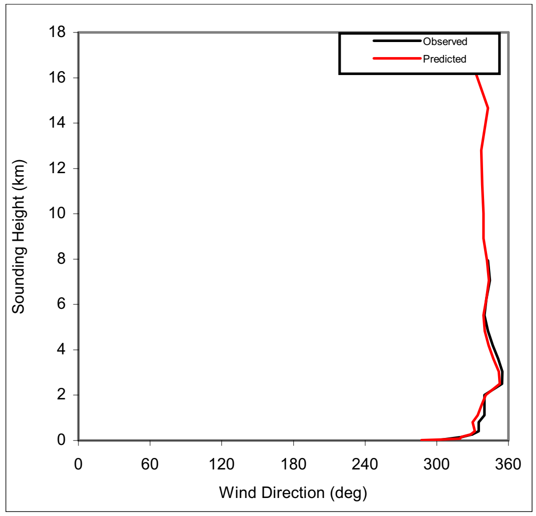
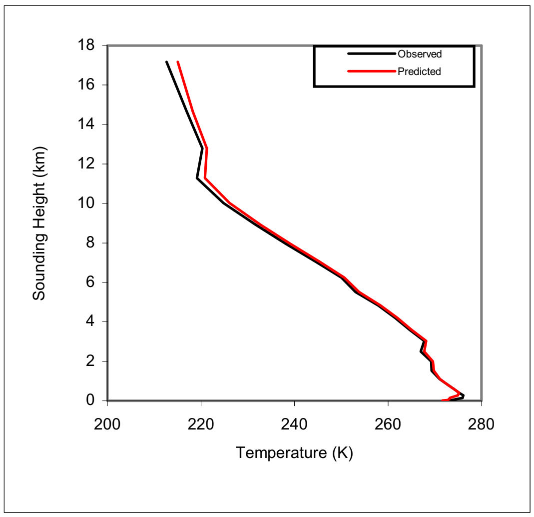
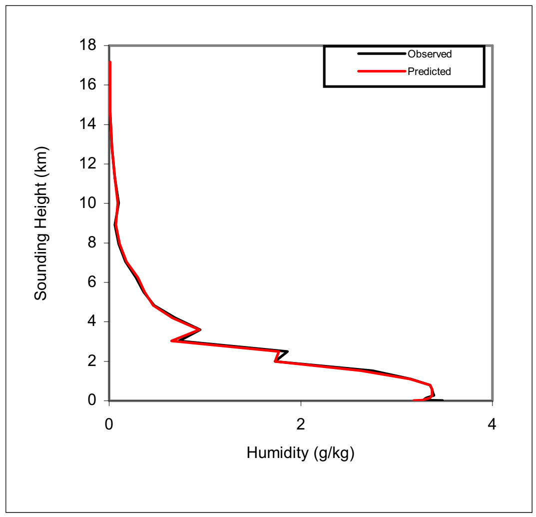
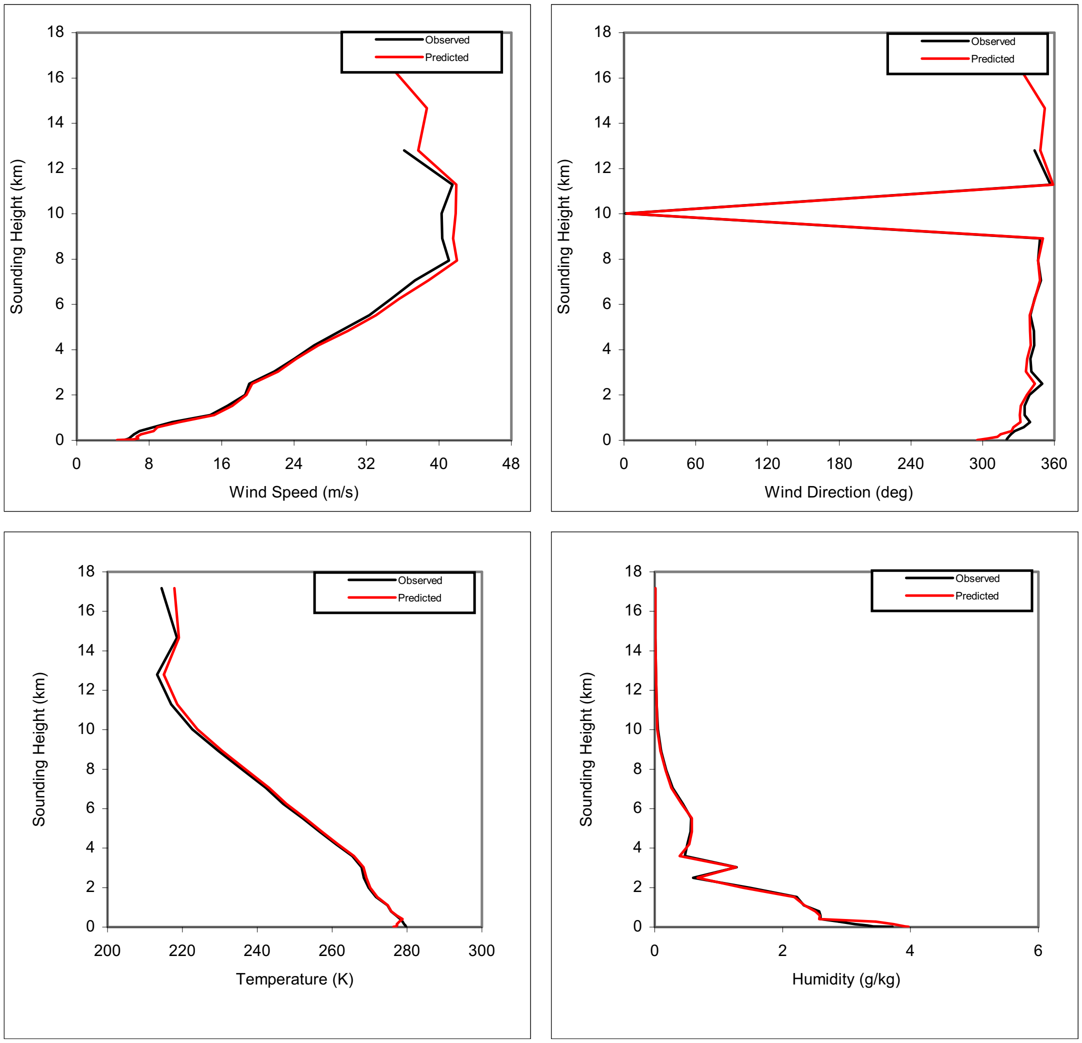








UP72681 Boise 1999122017 (run4)



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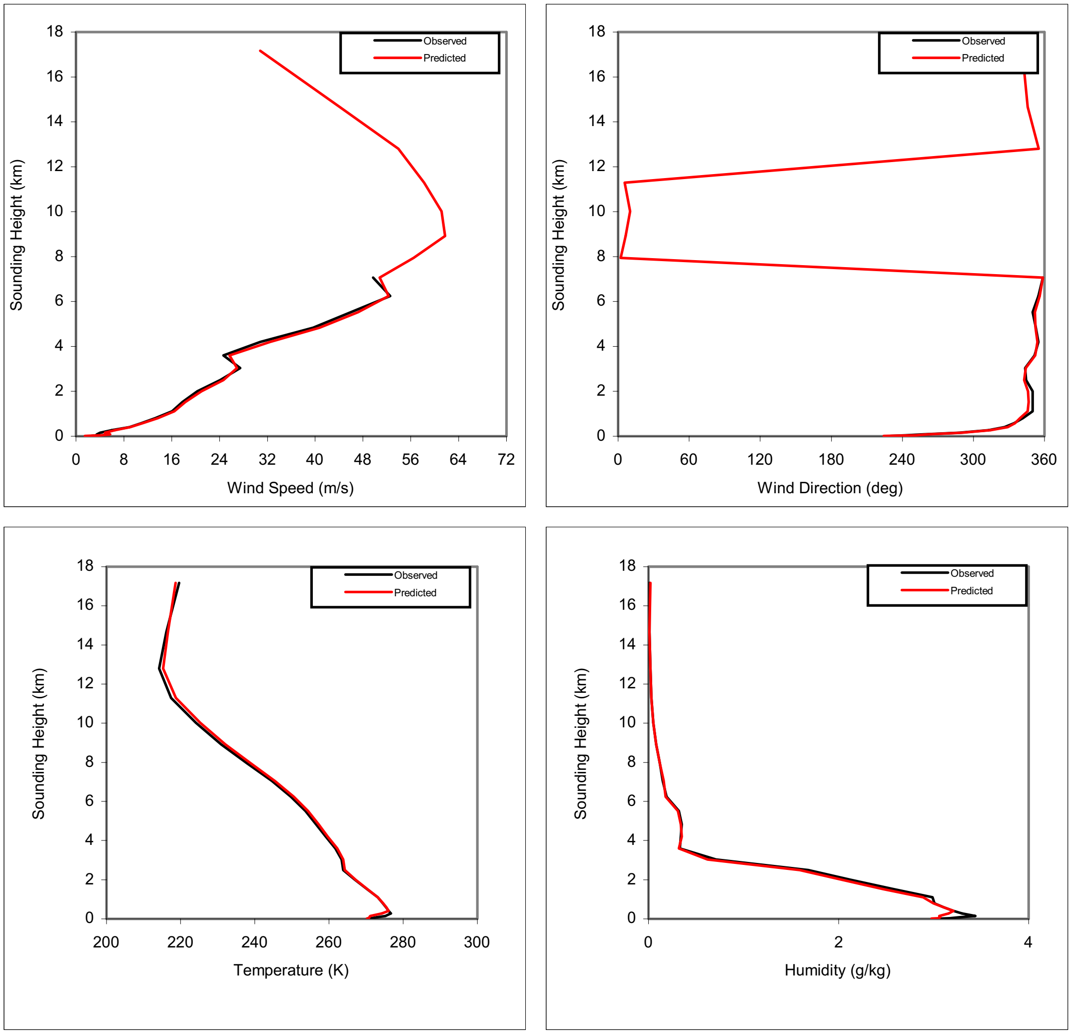

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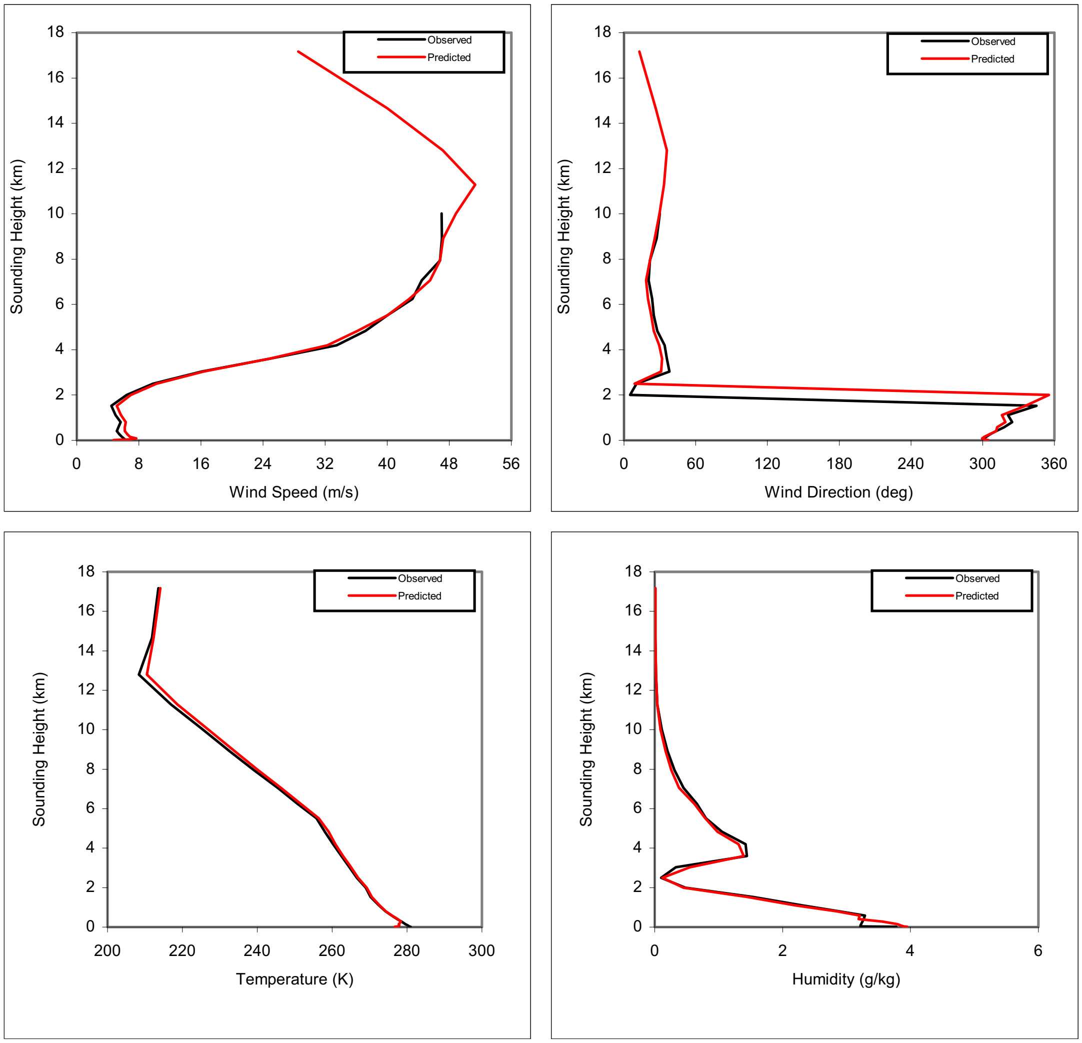

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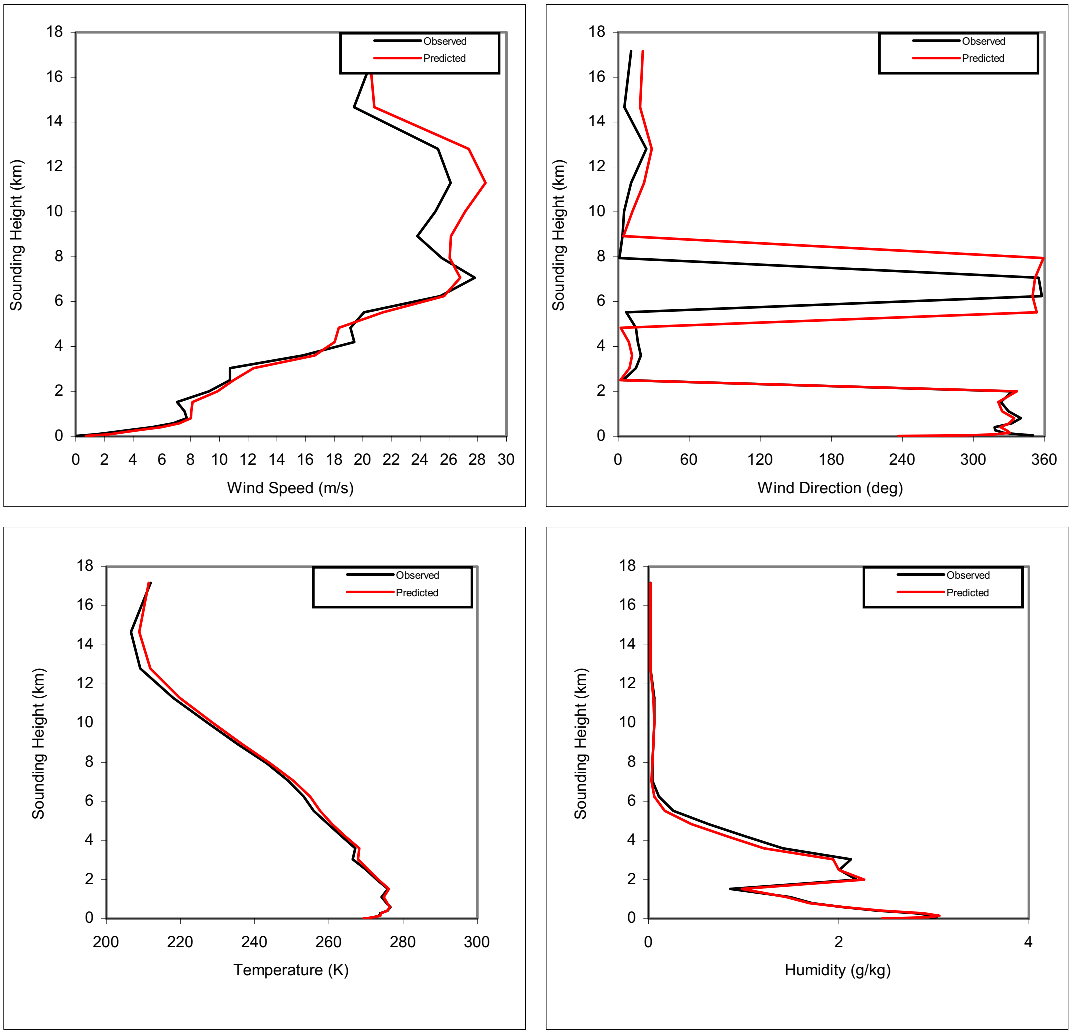

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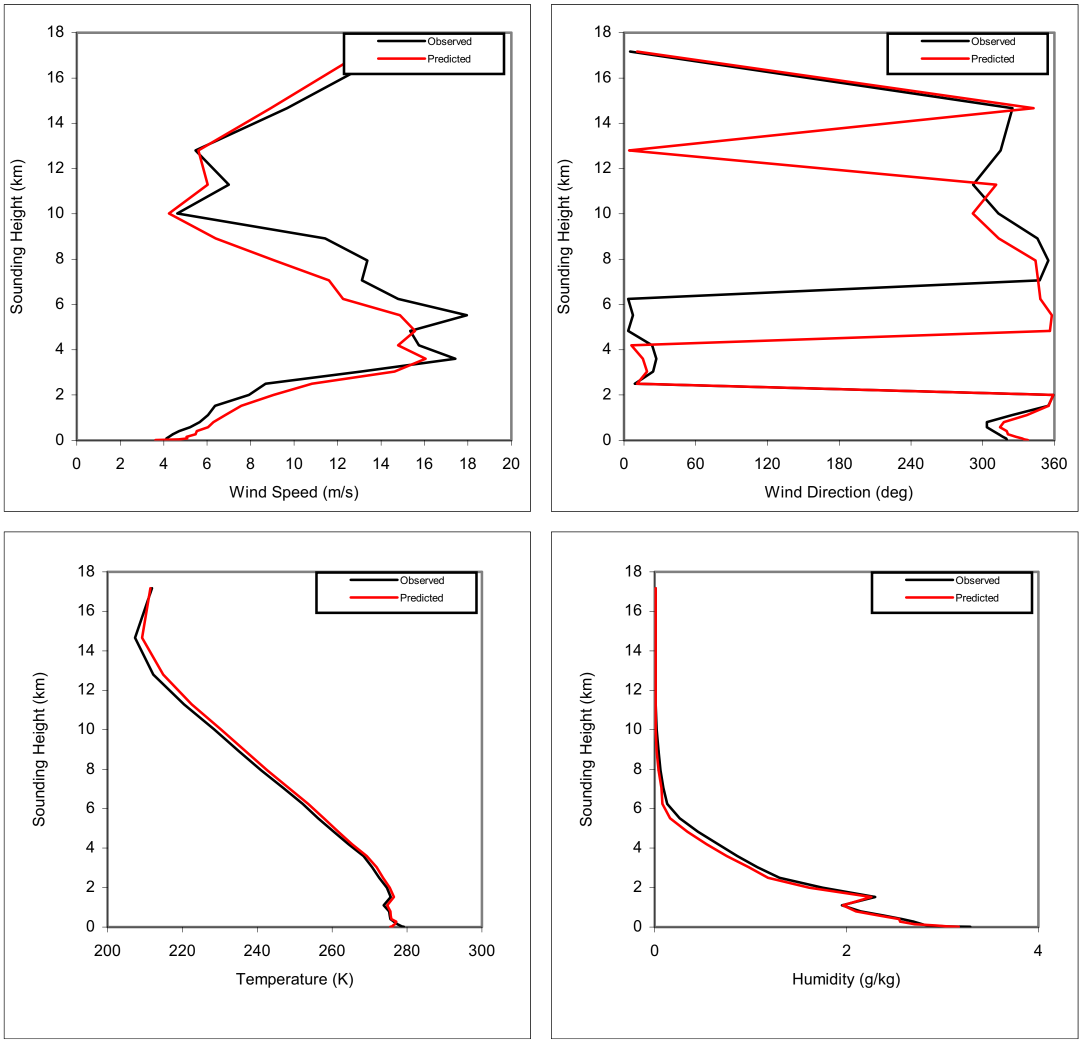

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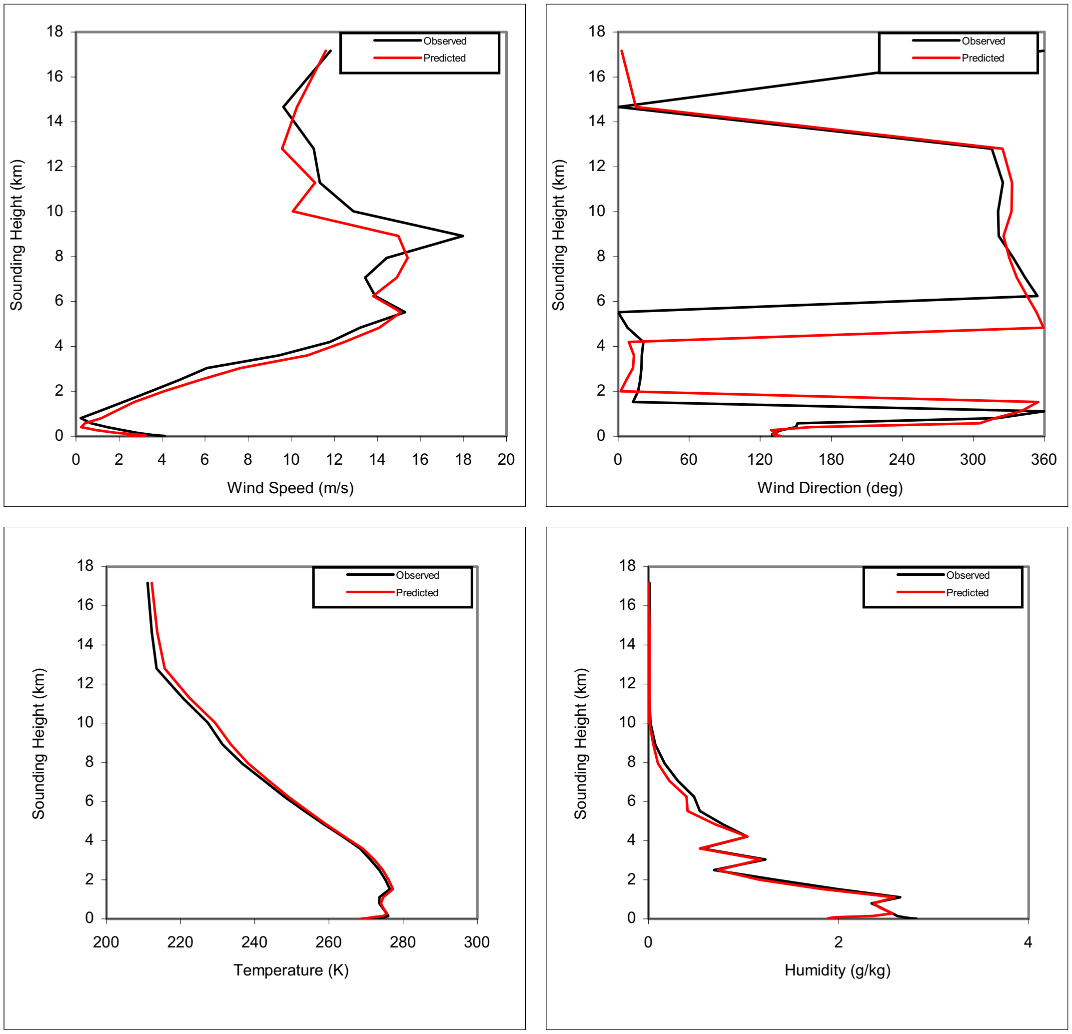

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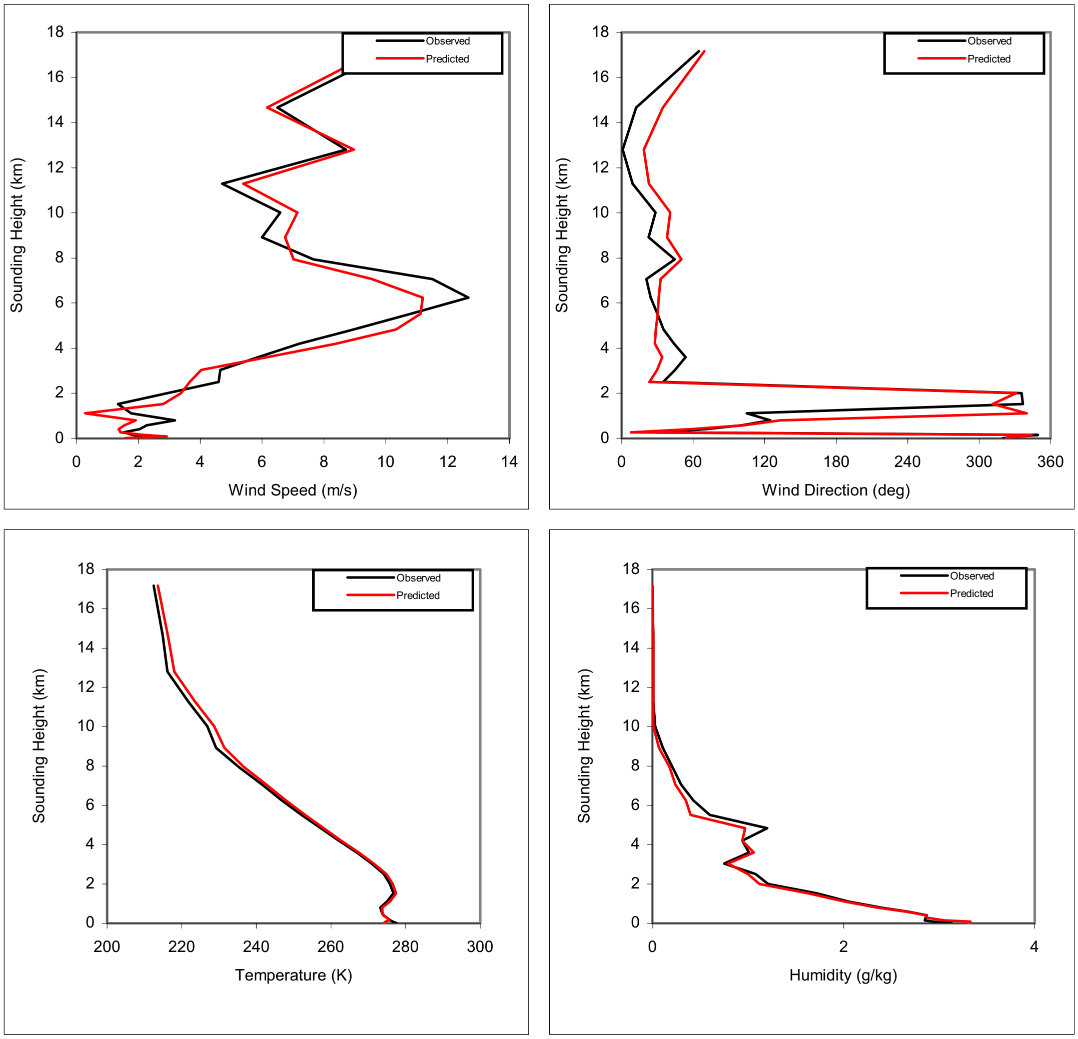

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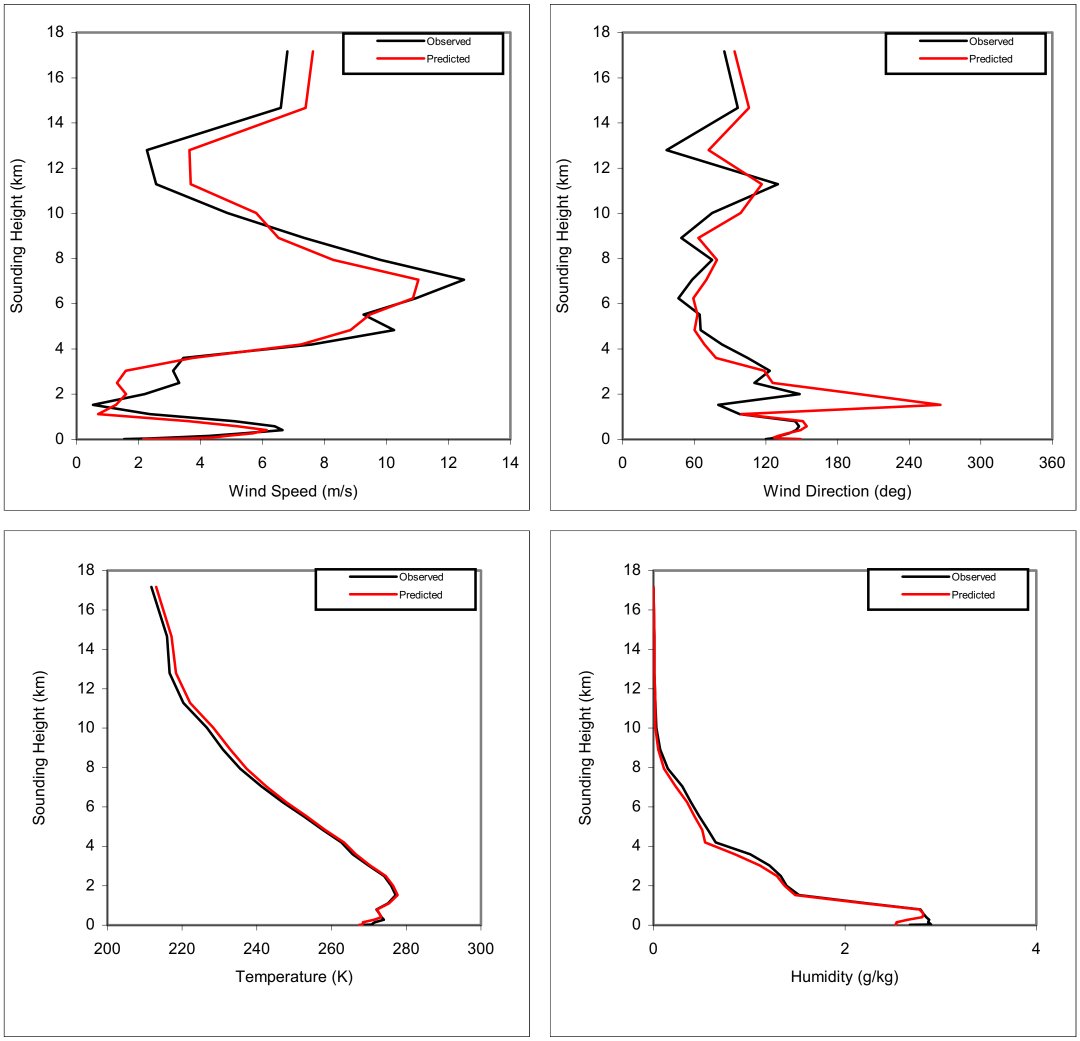

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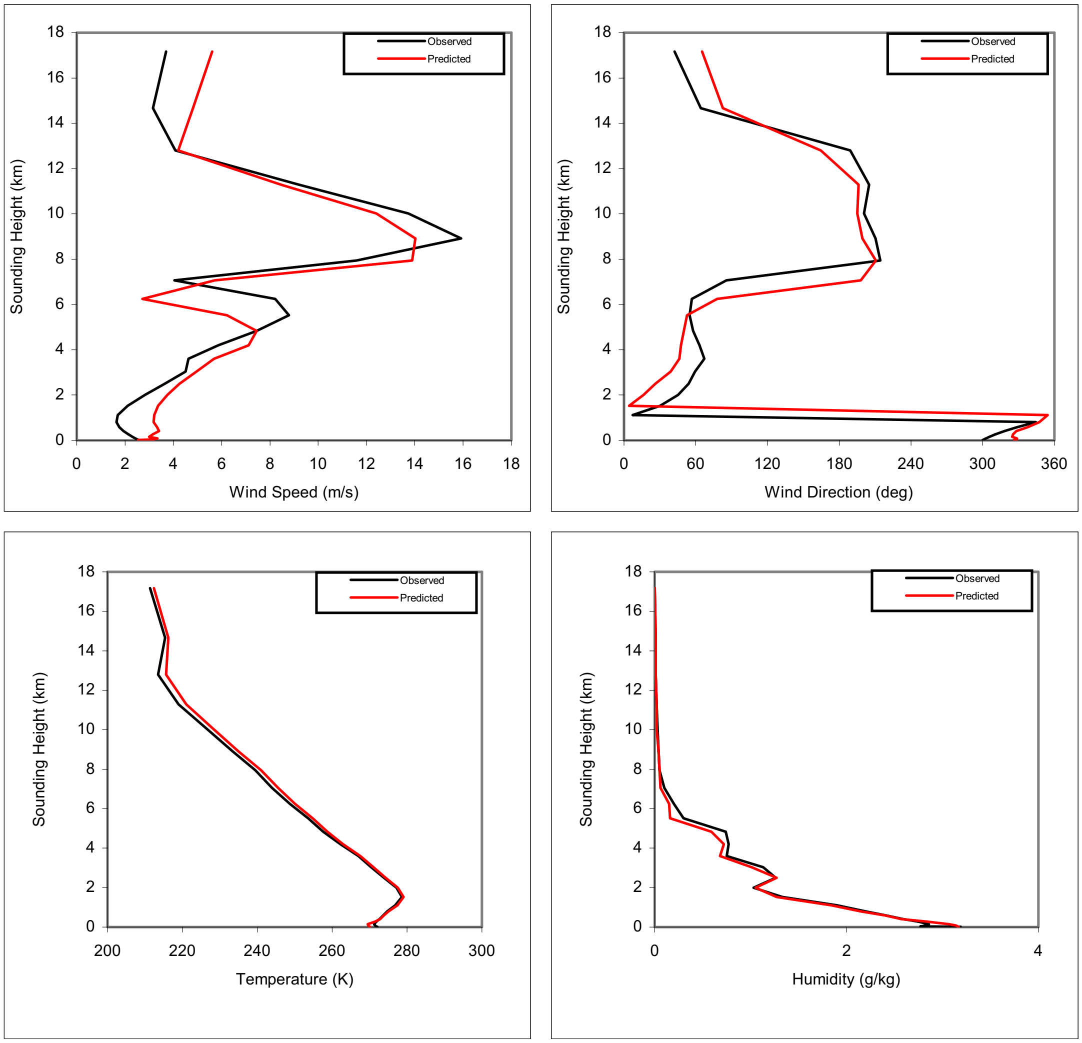

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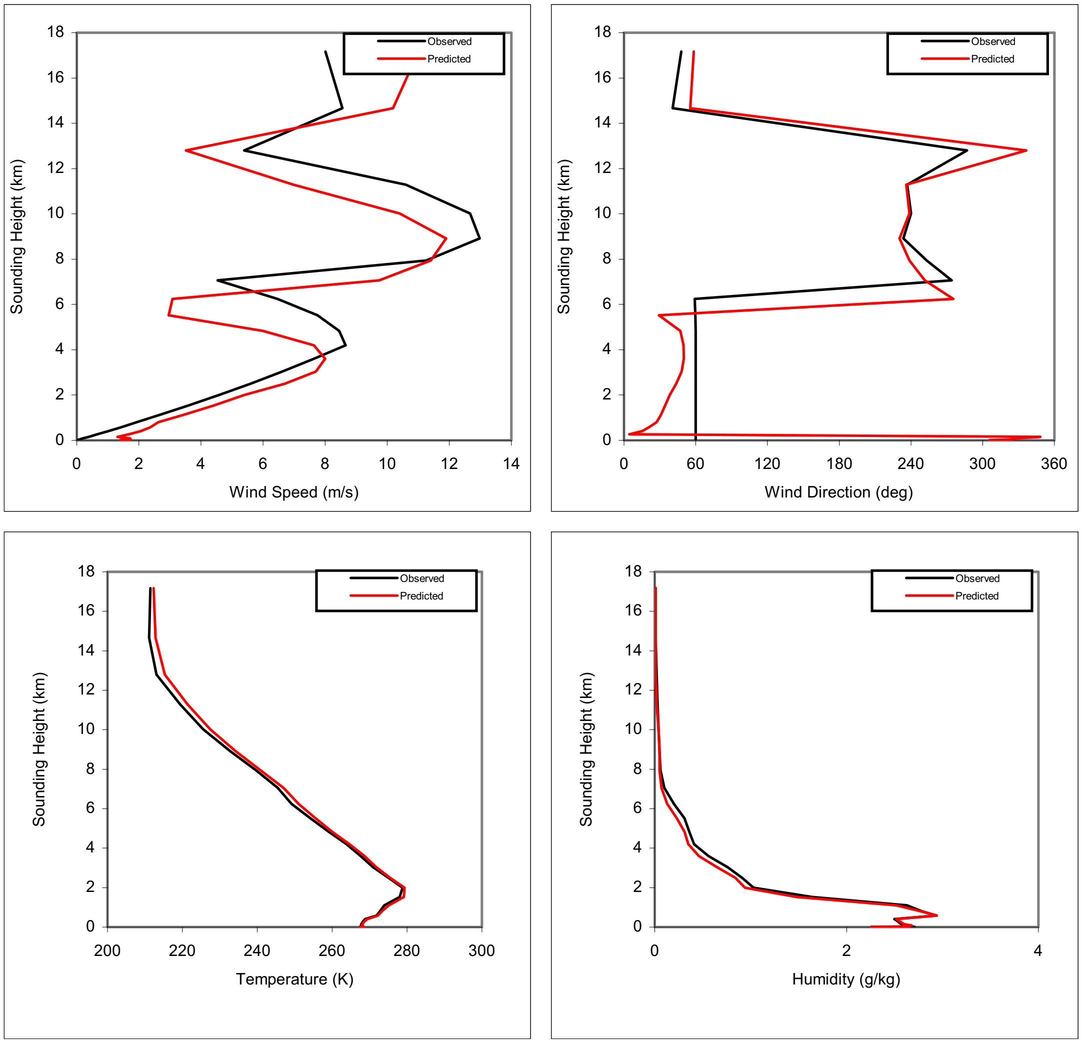

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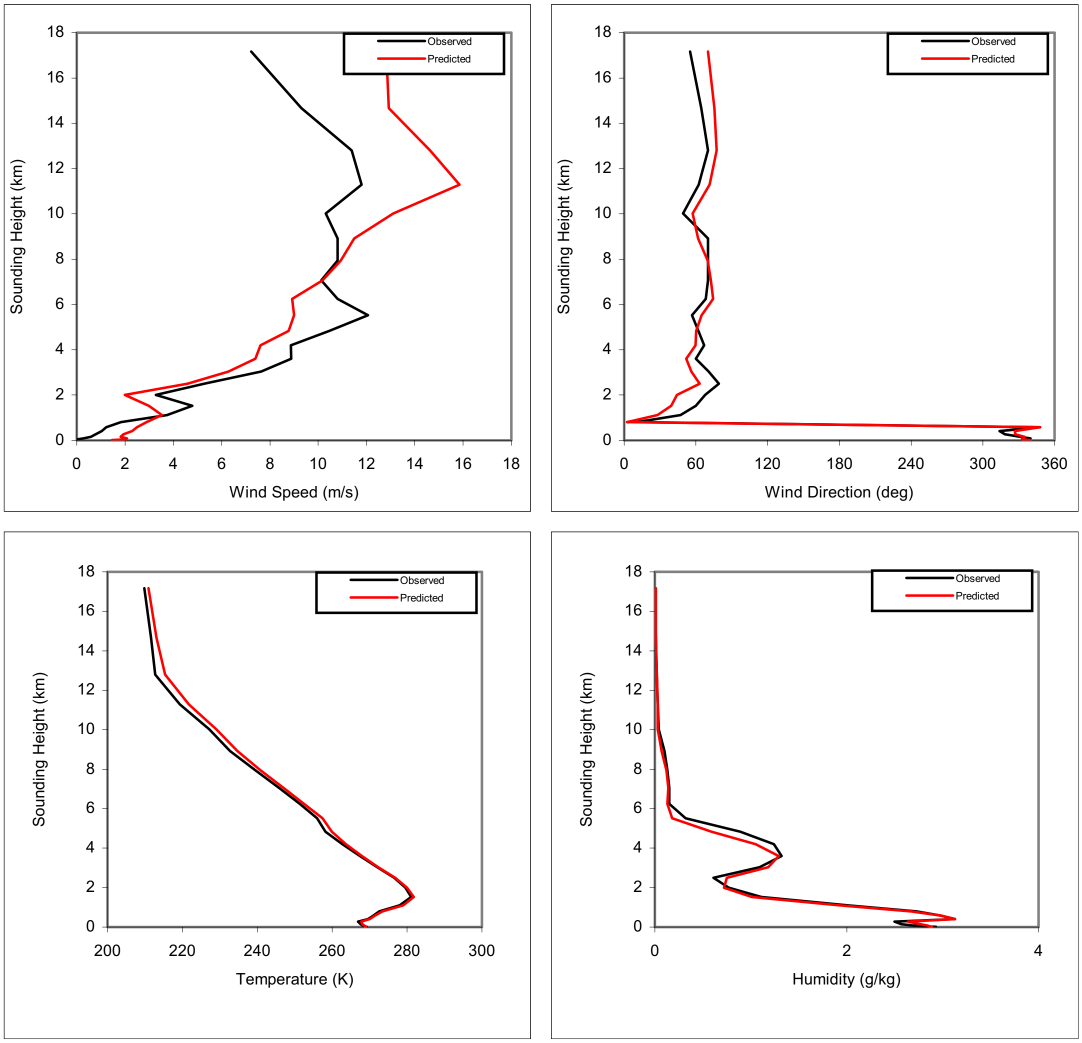

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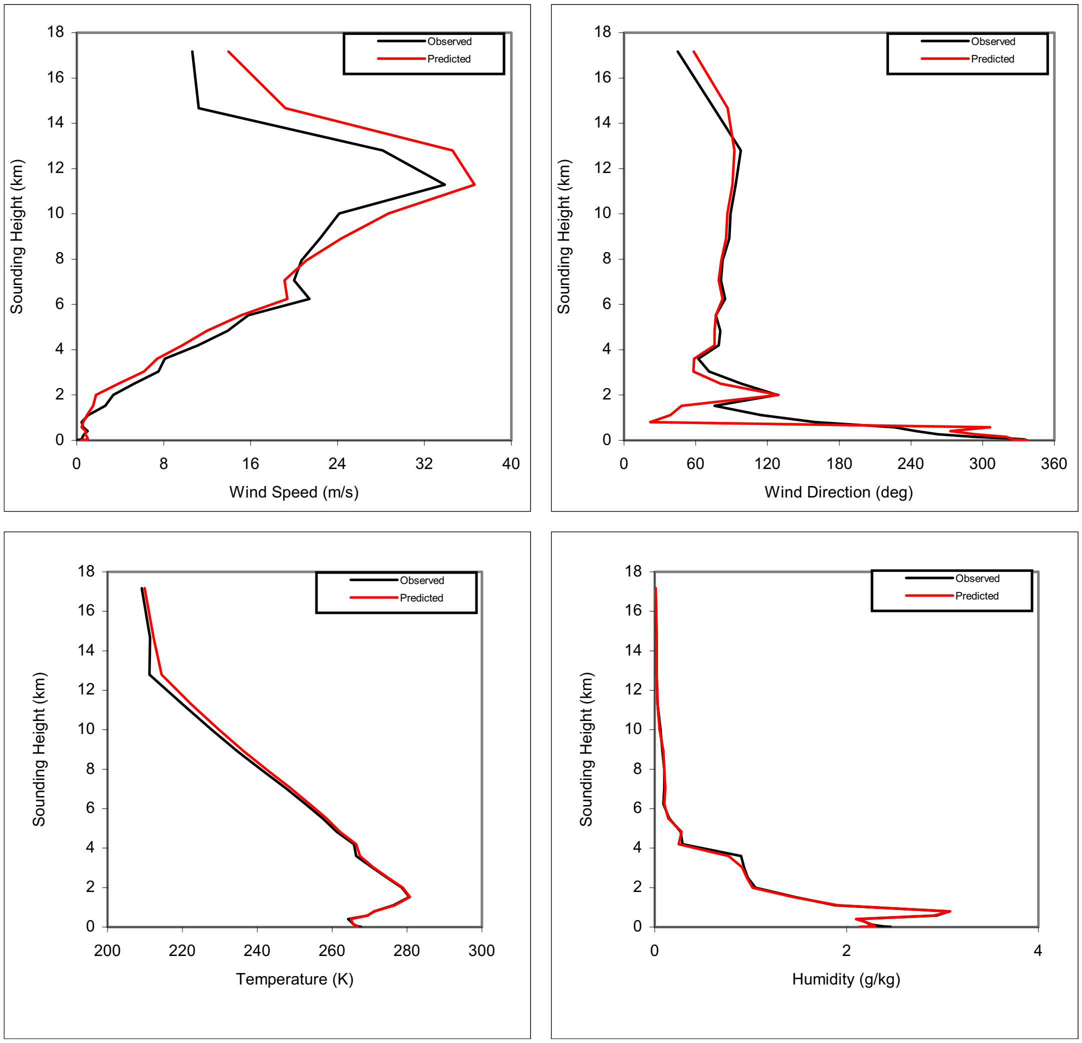

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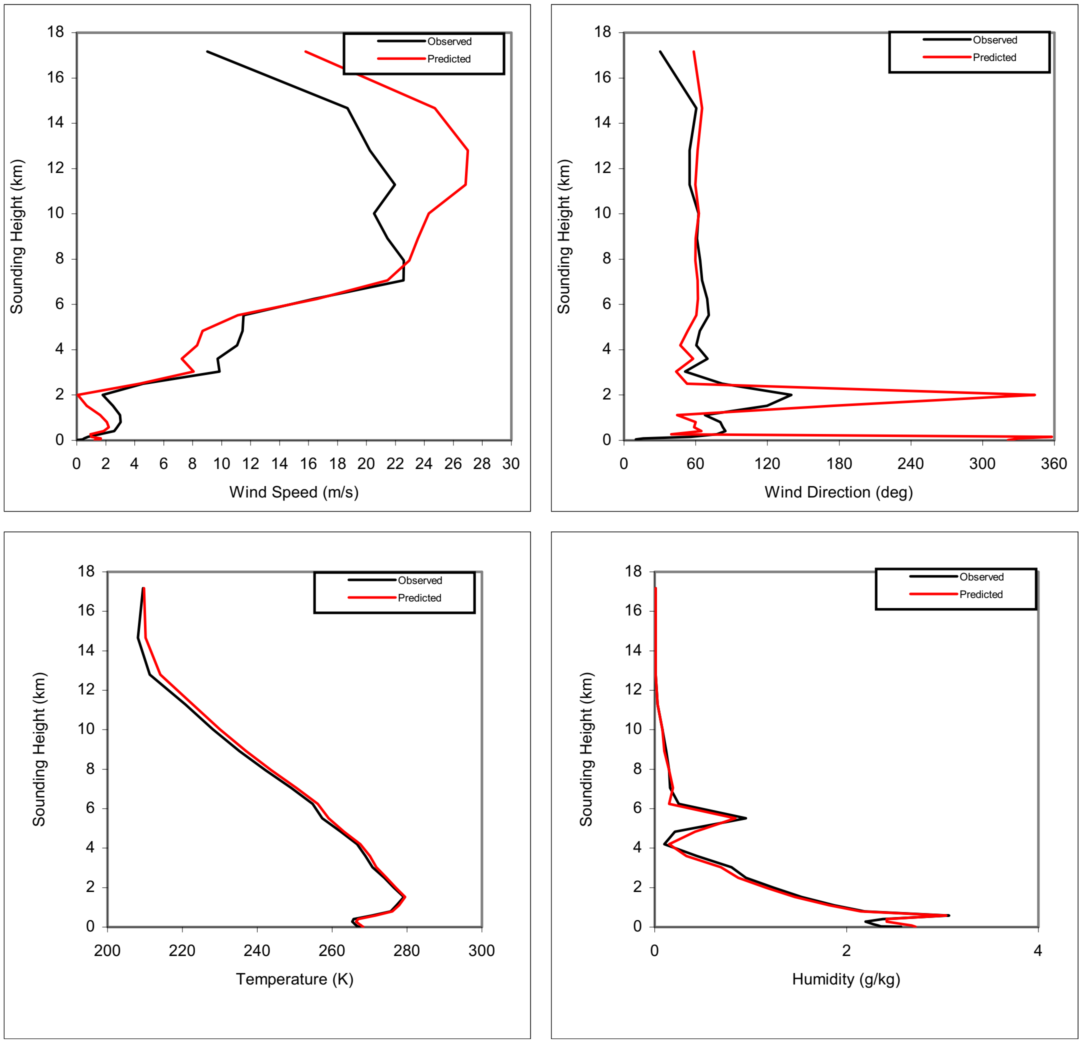
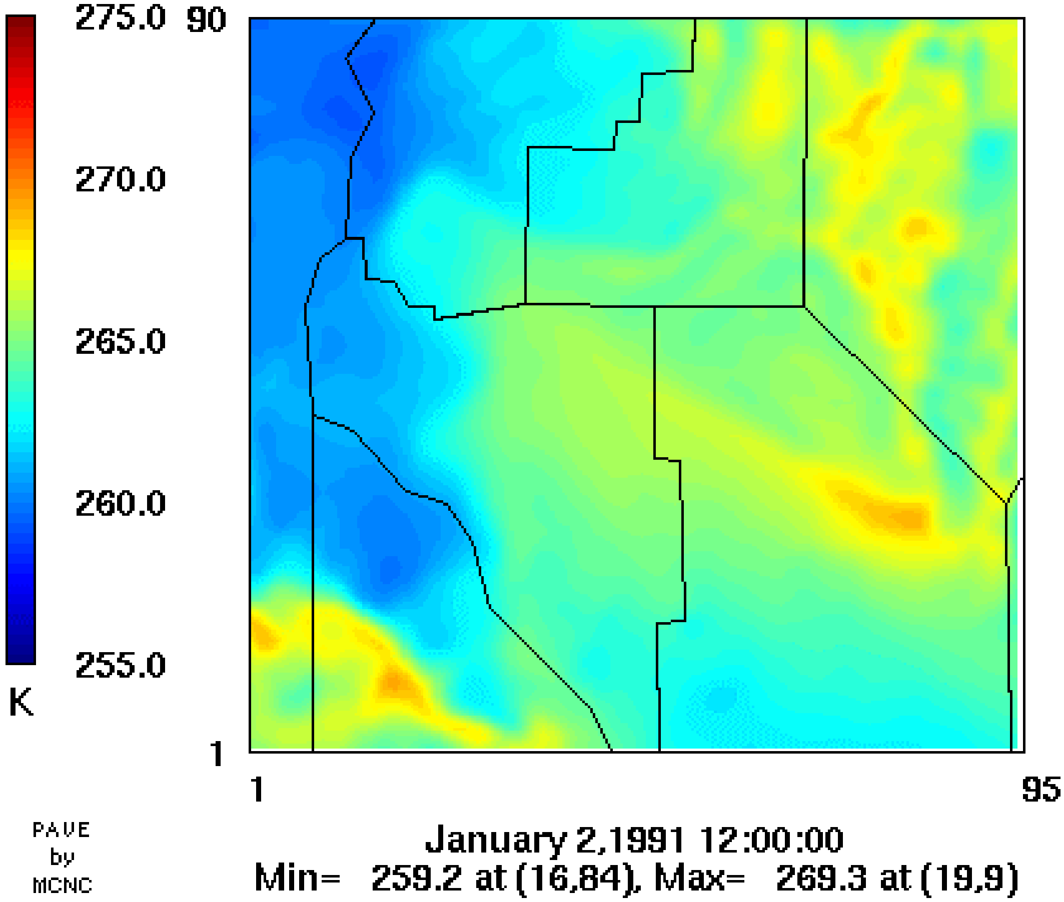


APPENDIX C

MM5 PREDICTED (RUN 11) TEMPERATURE AND WIND FIELDS AT NOON EACH DAY OF JANUARY 2-9, 1991

Layer 1 Temperature Field

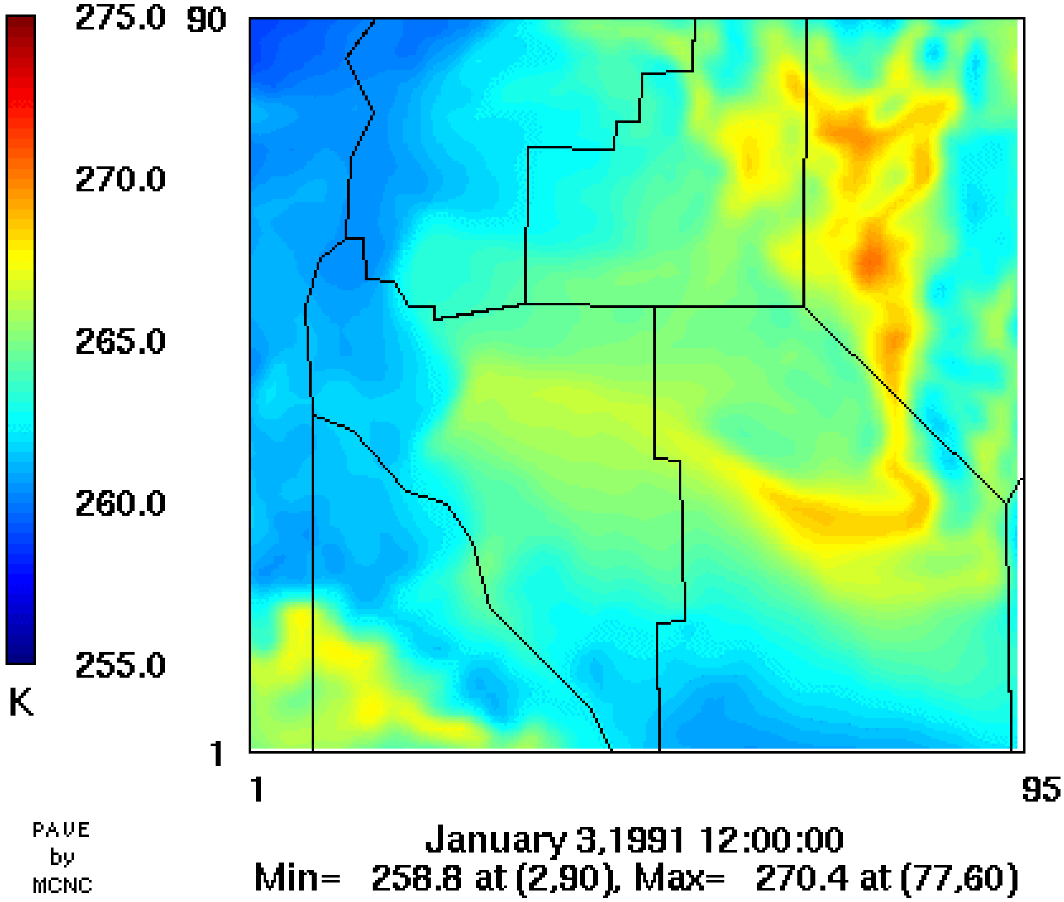
MM5-based run11 temperature field on the IDEQ CAMx grid



January 2,1991 12:00:00
Min=   259.2 at (16,84), Max=   269.3 at (19,9)

Layer 1 Temperature Field

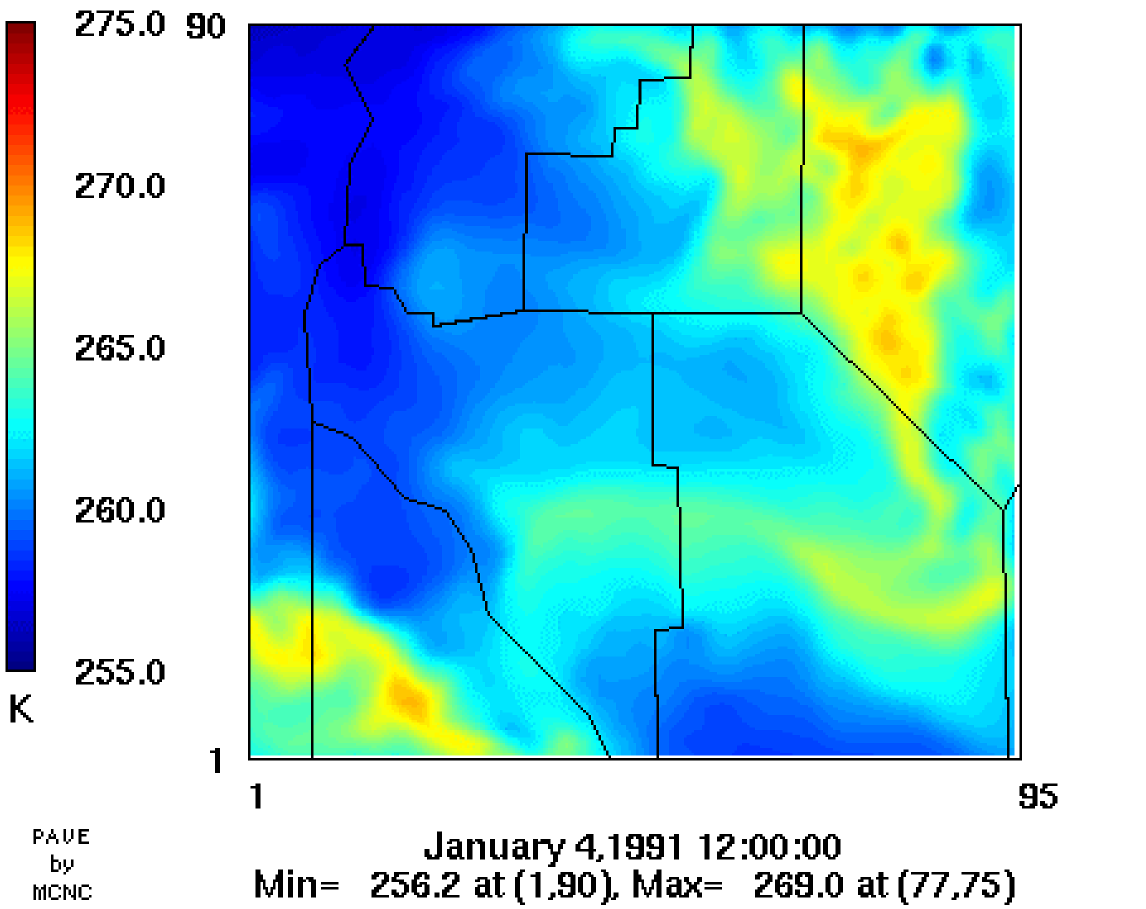
MM5-based run11 temperature field on the IDEQ CAMx grid



January 3,1991 12:00:00
Min= 258.8 at (2,90), Max= 270.4 at (77,60)

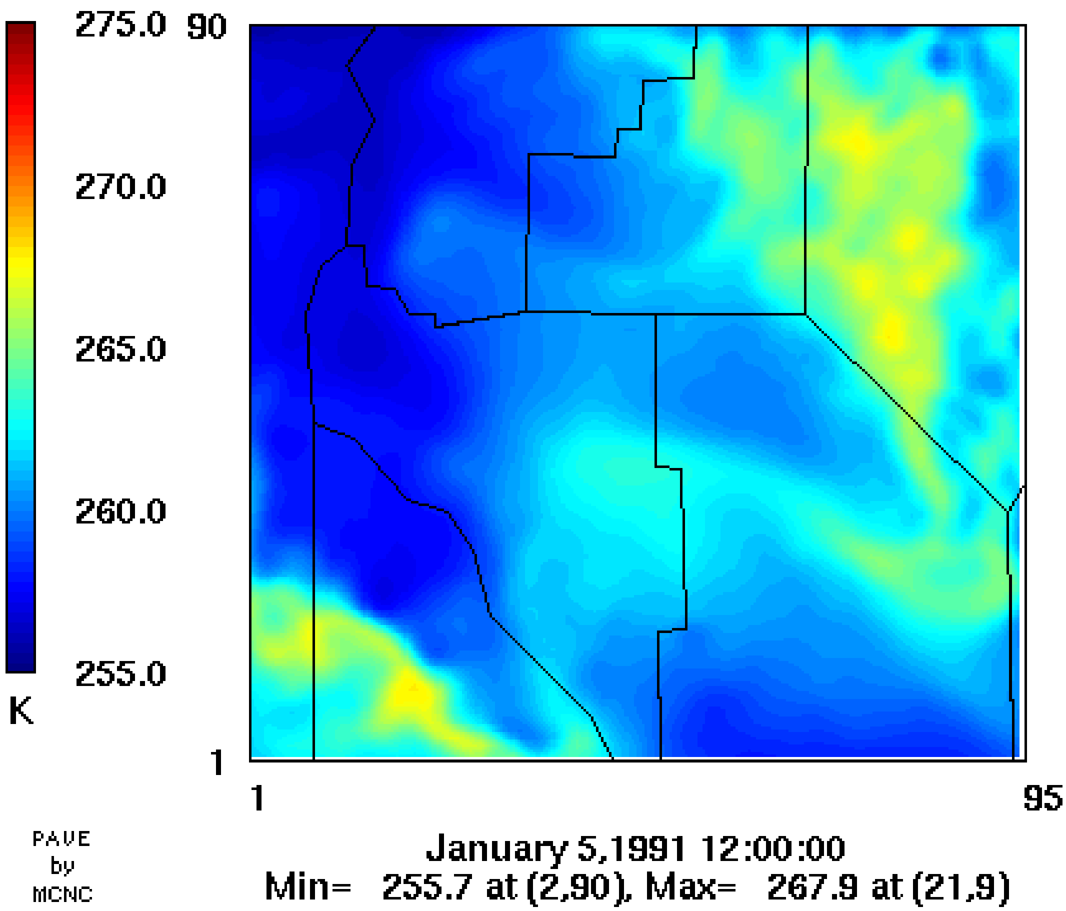
Layer 1 Temperature Field

MM5-based run11 temperature field on the IDEQ CAMx grid



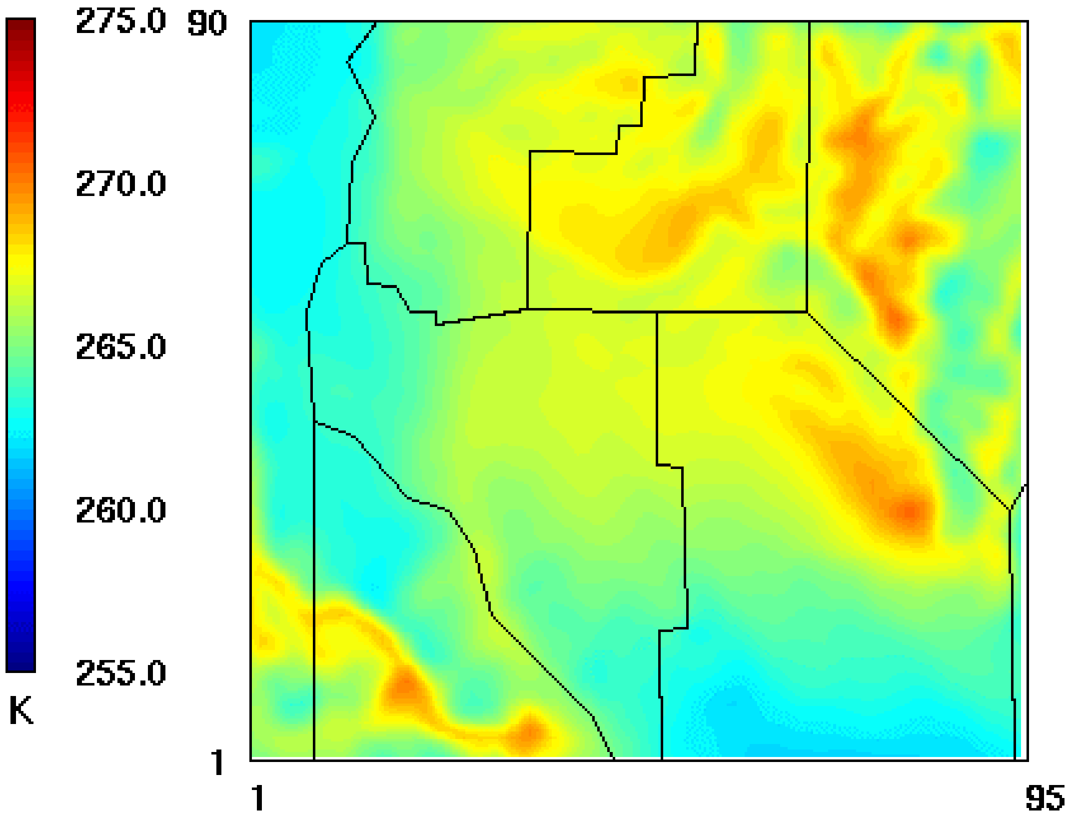
Layer 1 Temperature Field

MM5-based run11 temperature field on the IDEQ CAMx grid



Layer 1 Temperature Field

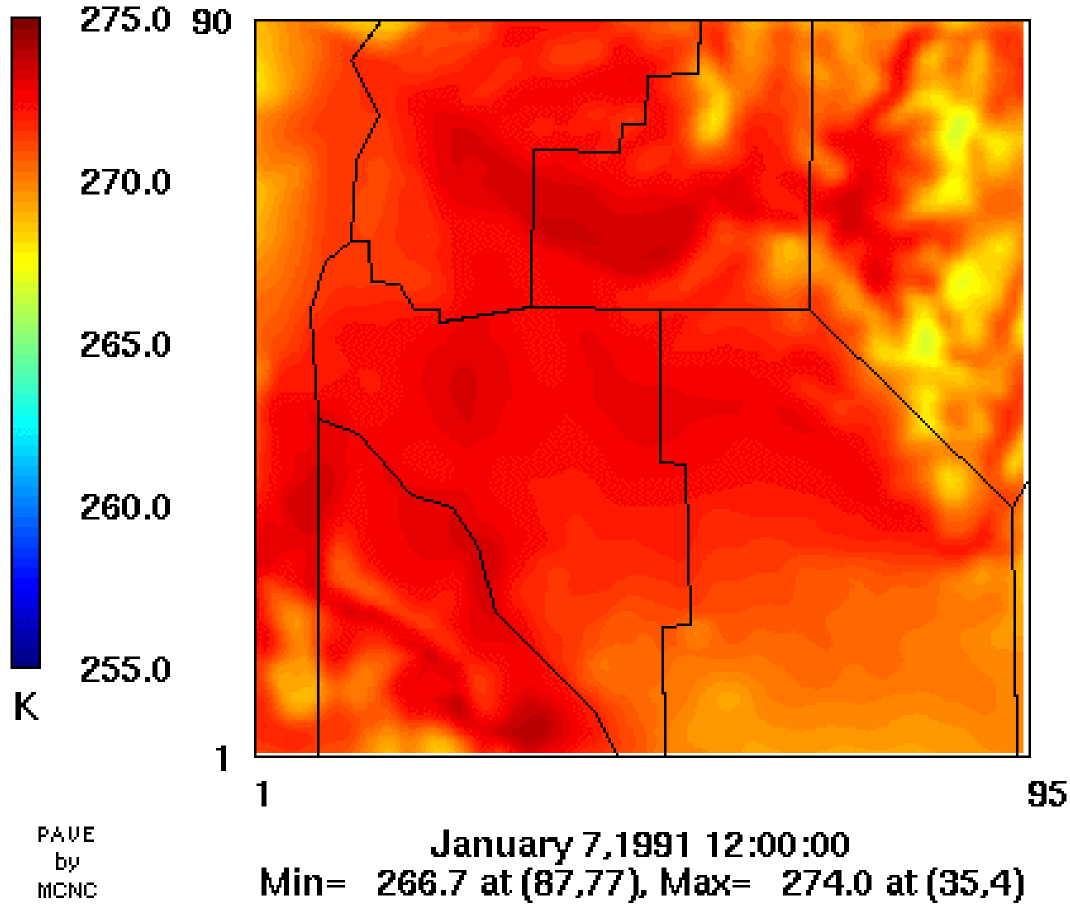
MM5-based run11 temperature field on the IDEQ CAMx grid



January 6,1991 12:00:00
Min= 261.7 at (73,1), Max= 270.4 at (82,30)

Layer 1 Temperature Field

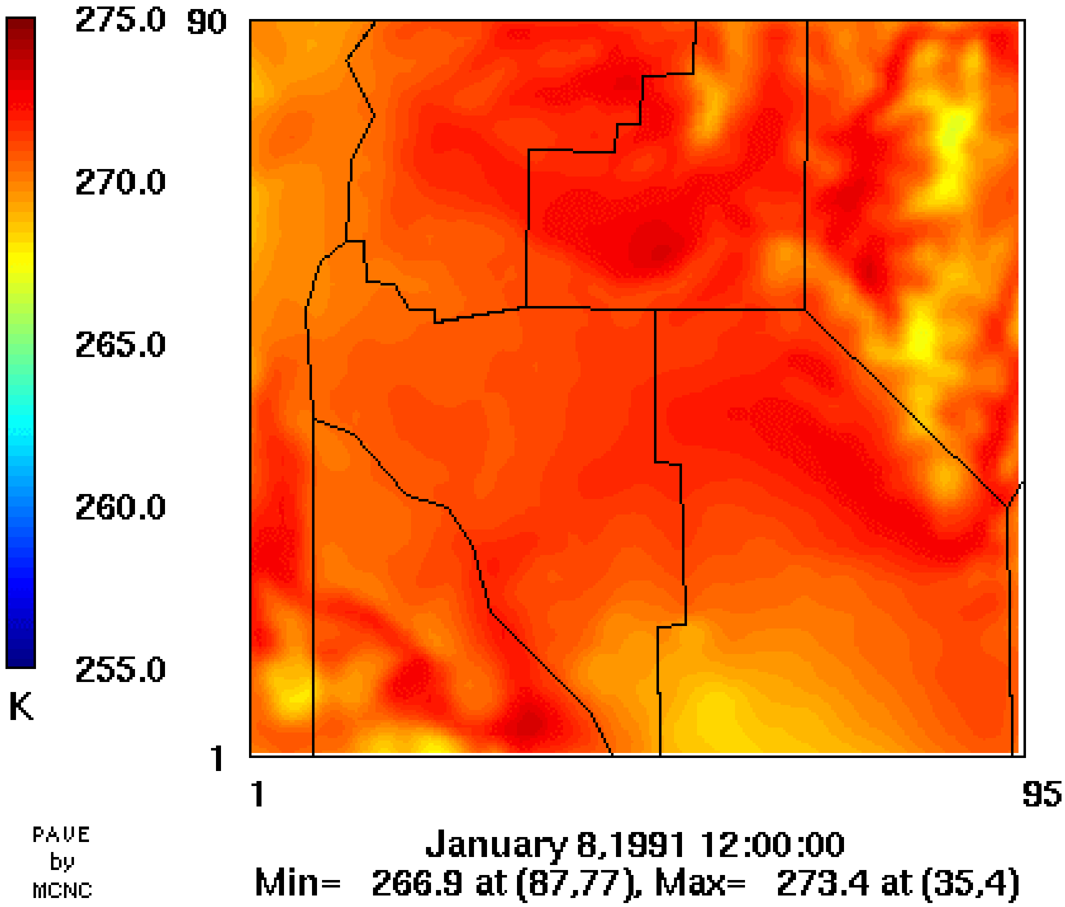
MM5-based run11 temperature field on the IDEQ CAMx grid



January 7,1991 12:00:00
Min=   266.7 at (87,77), Max=   274.0 at (35,4)

Layer 1 Temperature Field

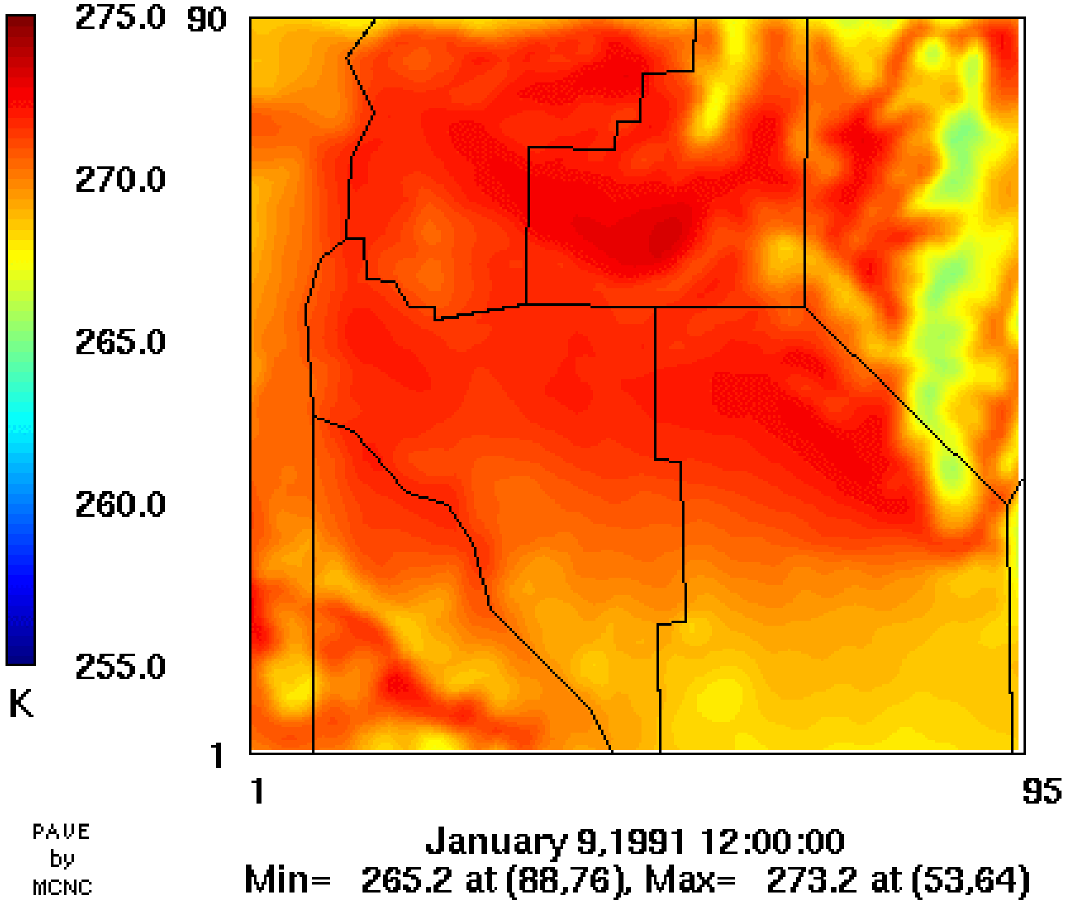
MM5-based run11 temperature field on the IDEQ CAMx grid



January 8,1991 12:00:00
Min= 266.9 at (87,77), Max= 273.4 at (35,4)

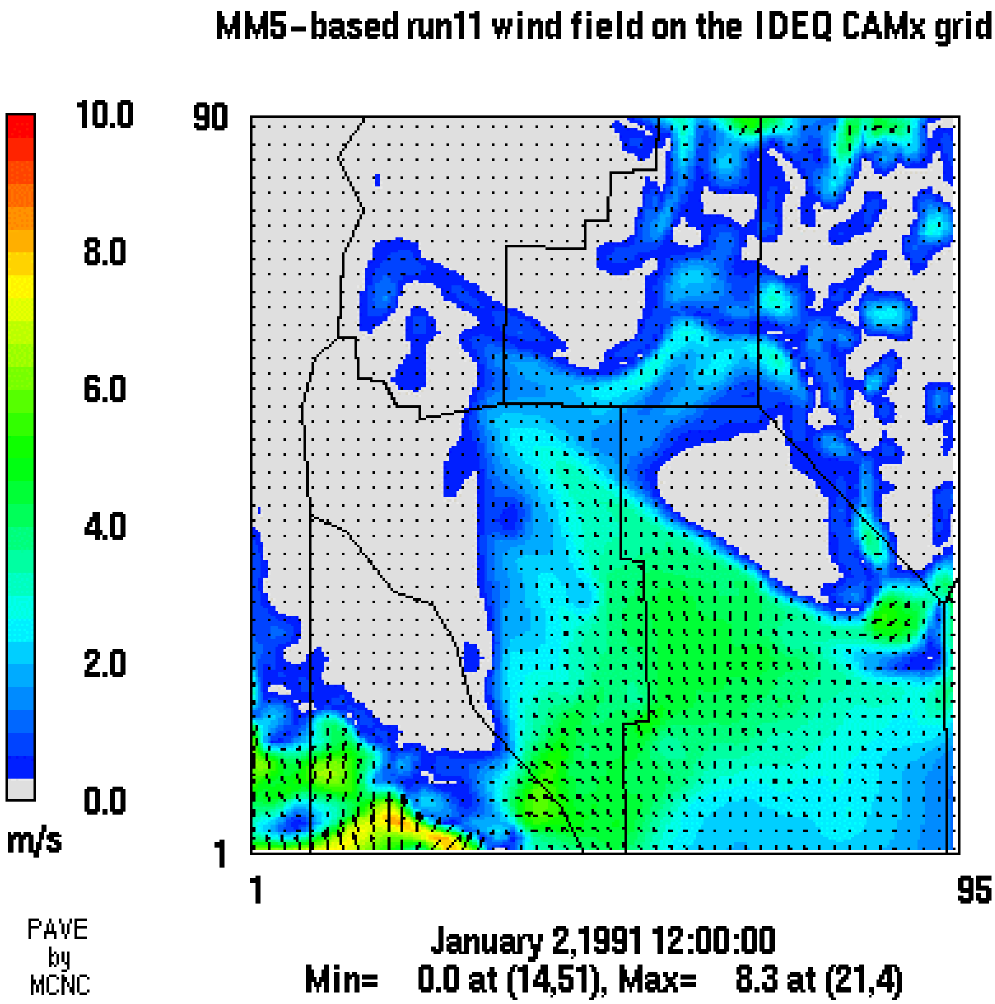
Layer 1 Temperature Field

MM5-based run11 temperature field on the IDEQ CAMx grid



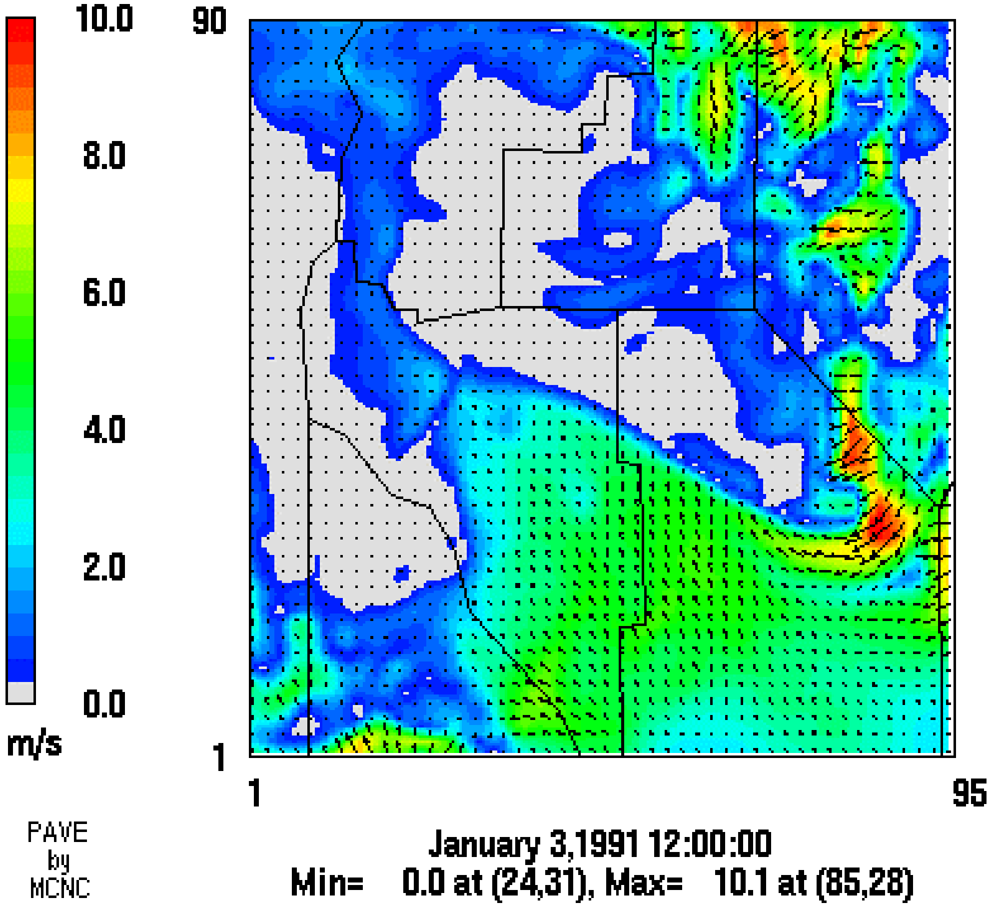
January 9,1991 12:00:00
Min= 265.2 at (88,76), Max= 273.2 at (53,64)

Layer 1 Wind Field



Layer 1 Wind Field

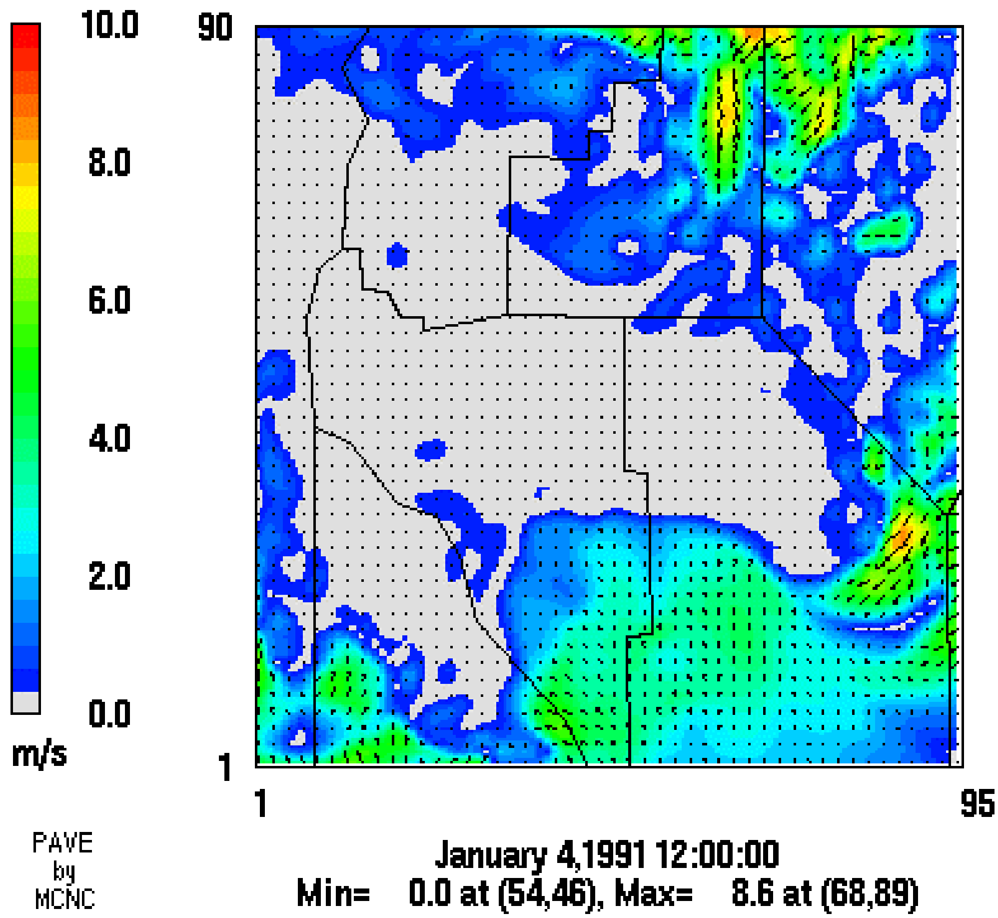
MM5-based run11 wind field on the IDEQ CAMx grid



January 3,1991 12:00:00
Min= 0.0 at (24,31), Max= 10.1 at (85,28)

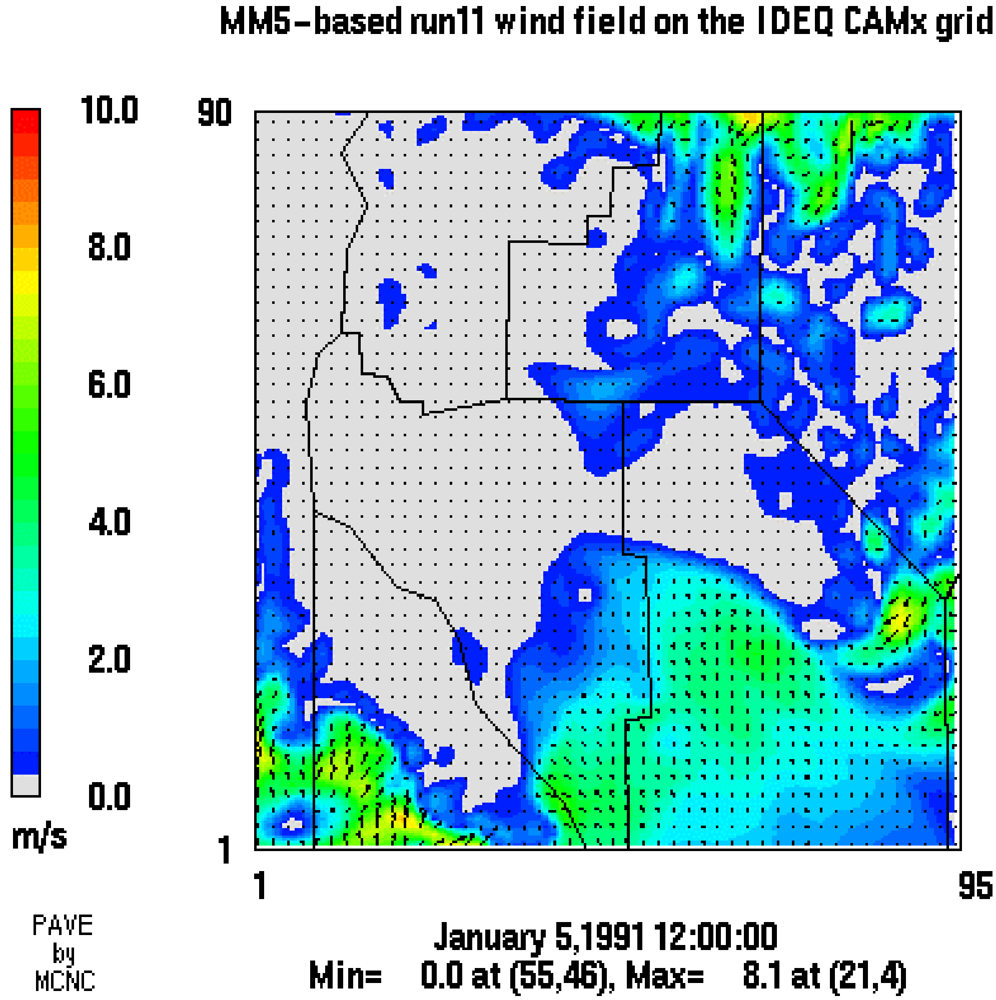
Layer 1 Wind Field

MM5-based run11 wind field on the IDEQ CAMx grid



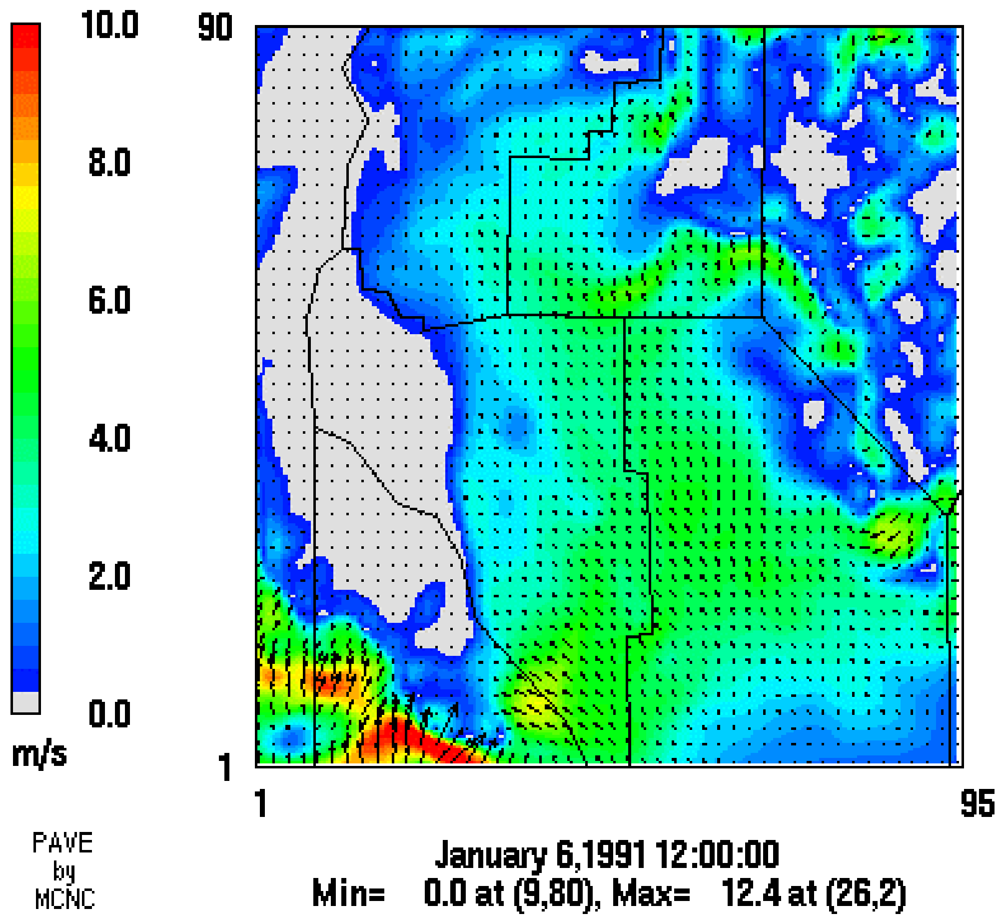
January 4,1991 12:00:00
Min= 0.0 at (54,46), Max= 8.6 at (68,89)

Layer 1 Wind Field



Layer 1 Wind Field

MM5-based run11 wind field on the IDEQ CAMx grid



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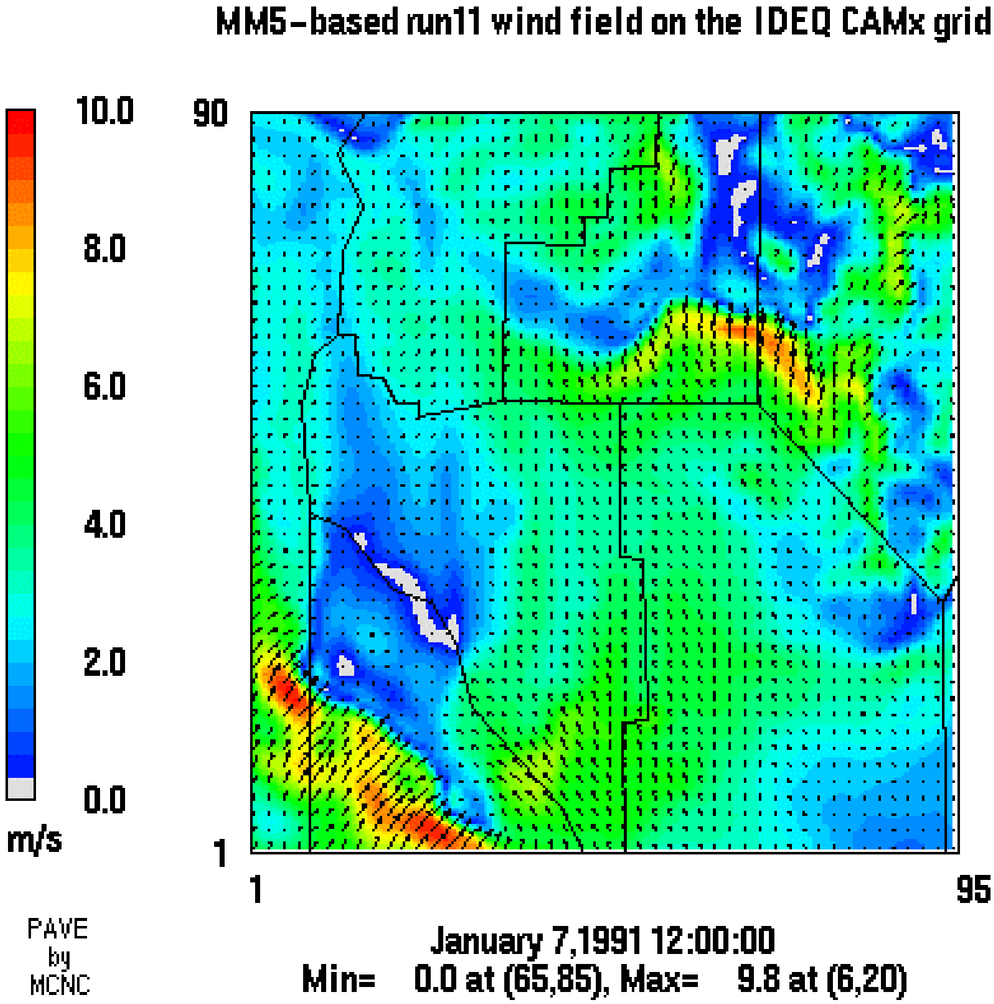
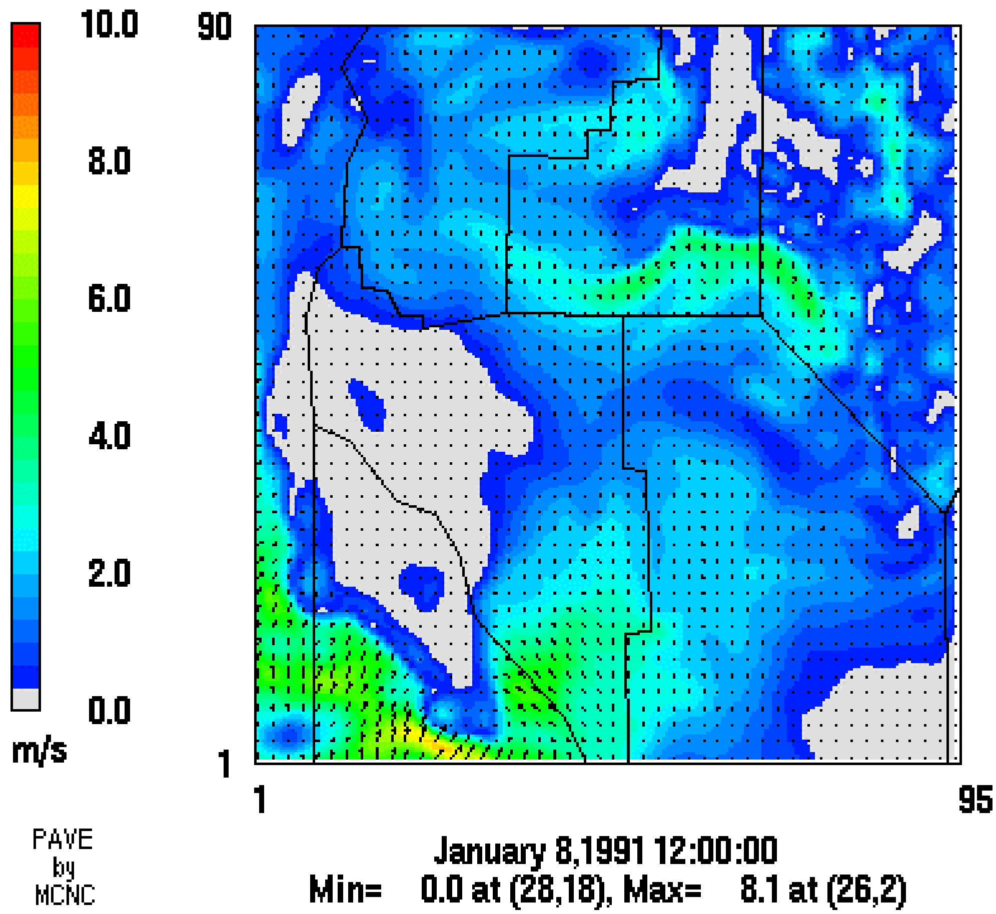


Layer 1 Wind Field

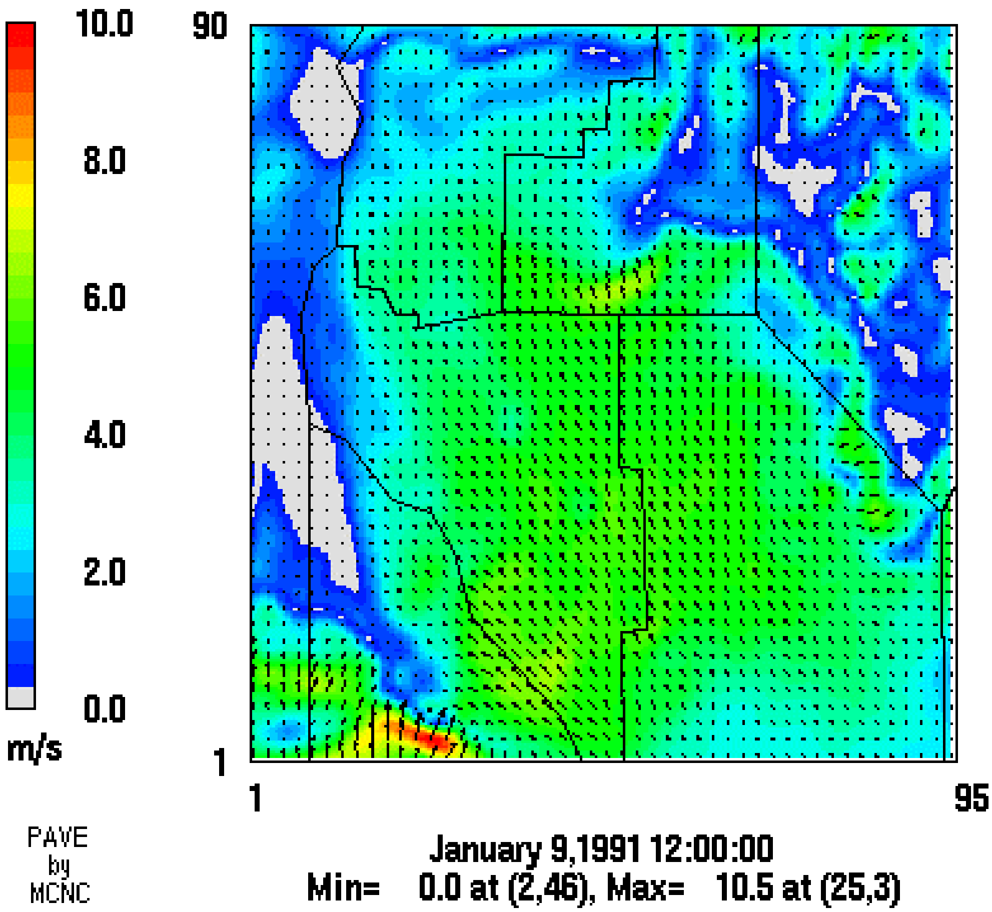
MM5-based run11 wind field on the IDEQ CAMx grid



January 8,1991 12:00:00
Min= 0.0 at (28,18), Max= 8.1 at (26,2)

Layer 1 Wind Field

MM5-based run11 wind field on the IDEQ CAMx grid

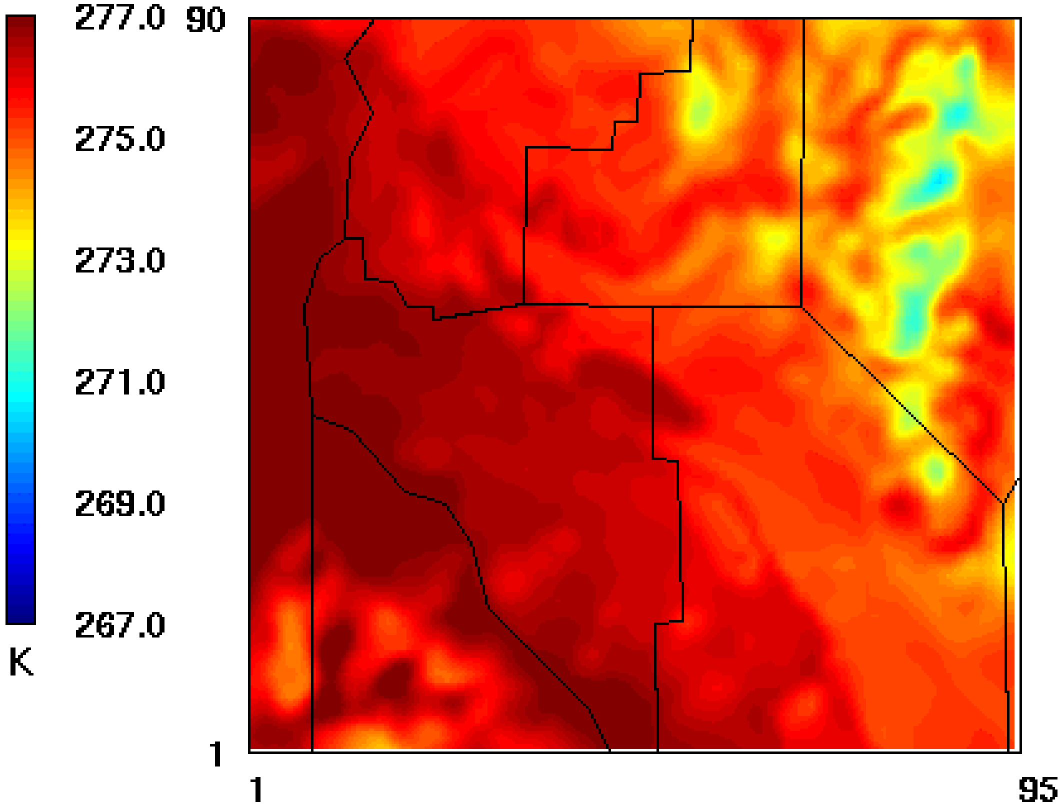


APPENDIX D

MM5 PREDICTED (RUN 4) TEMPERATURE AND WIND AT NOON EACH DAY OF DECEMBER 20-26, 1999

Layer 1 Temperature Field

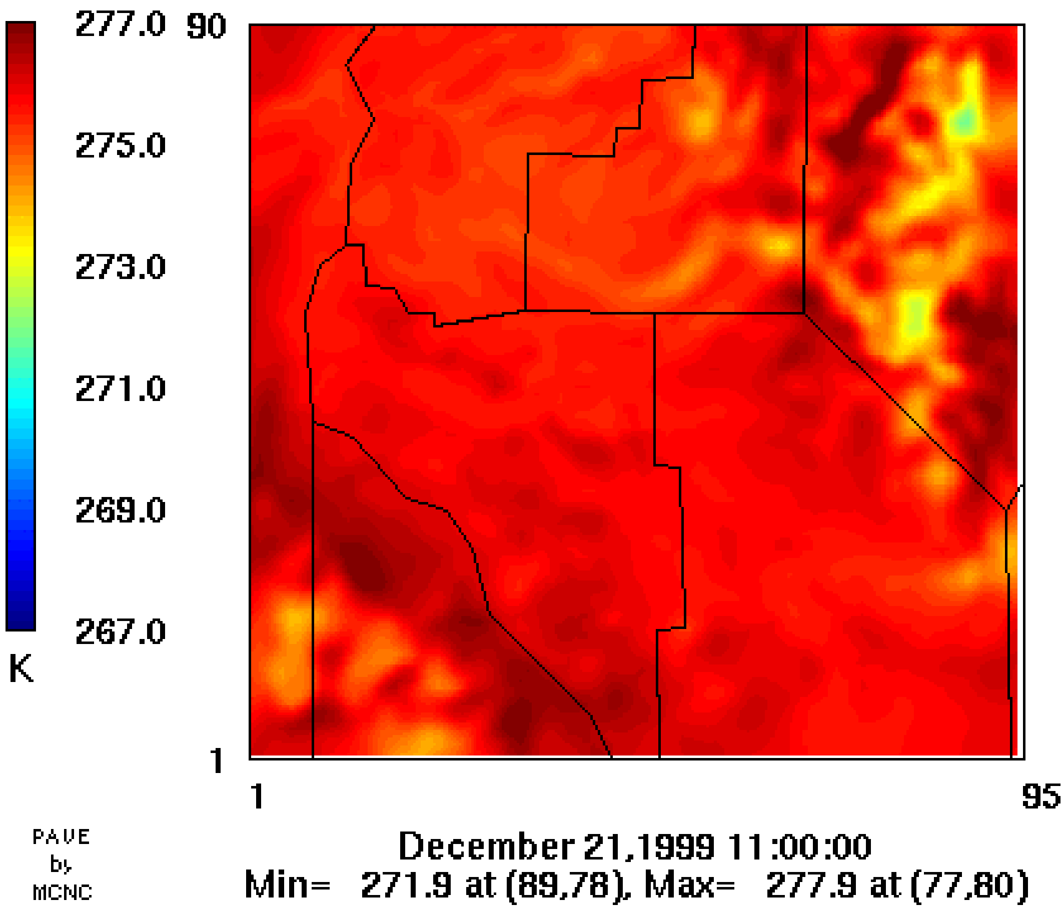
MM5-based run 4 temperature field on the IDEQ CAMx grid



December 20,1999 12:00:00
Min= 270.5 at (86,70), Max= 277.5 at (1,33)

Layer 1 Temperature Field

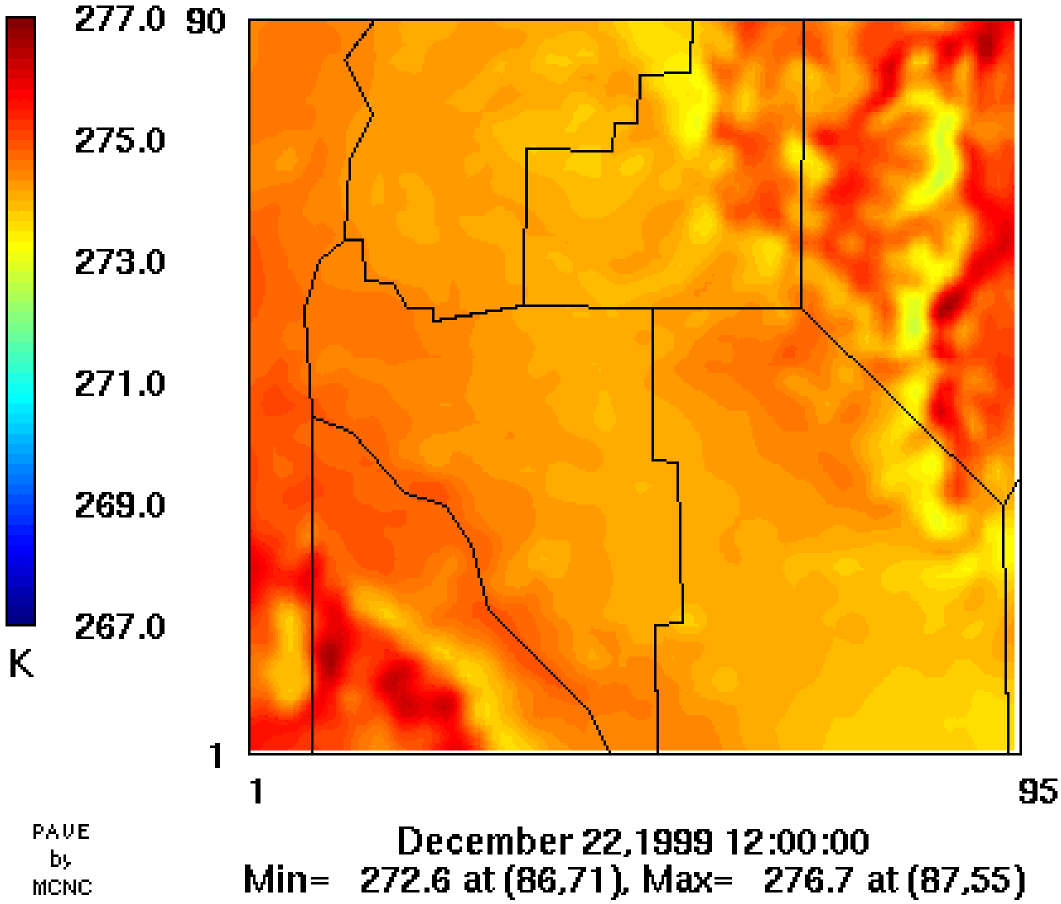
MM5-based run 4 temperature field on the IDEQ CAMx grid



December 21,1999 11:00:00
Min= 271.9 at (89,78), Max= 277.9 at (77,80)

Layer 1 Temperature Field

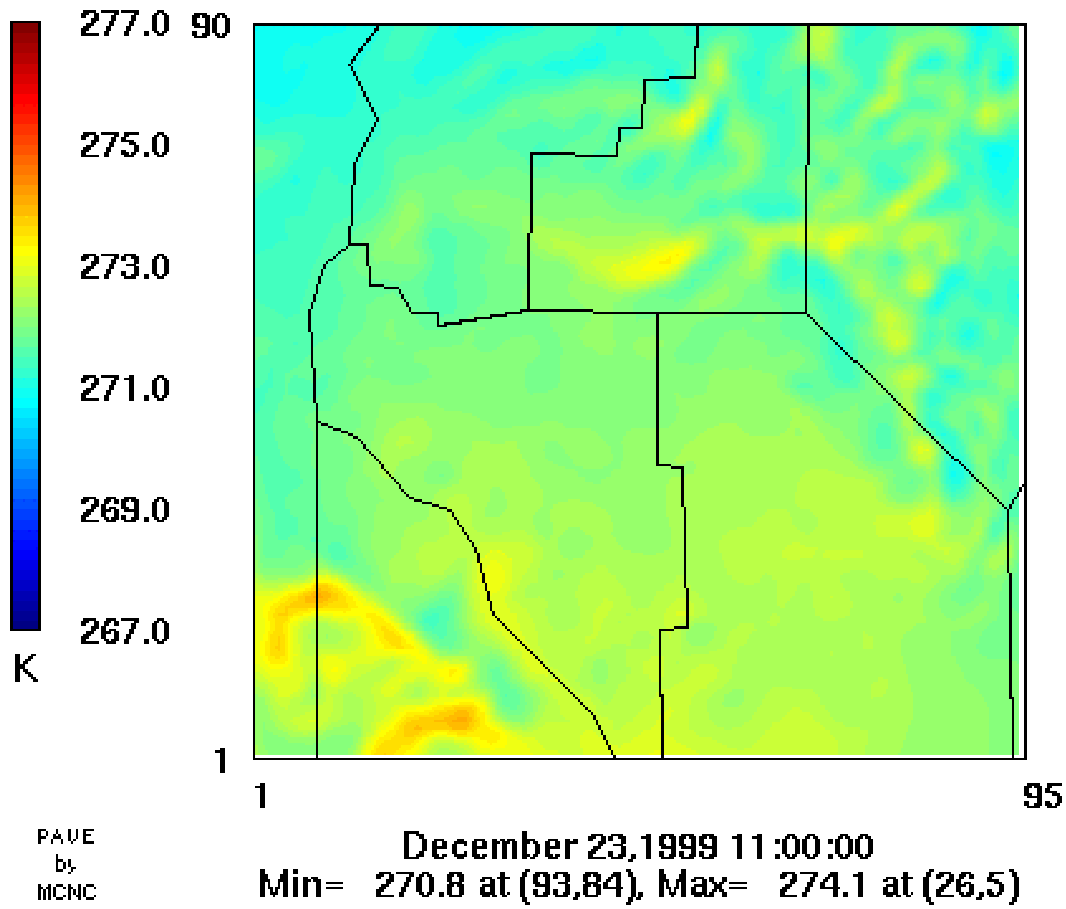
MM5-based run 4 temperature field on the IDEQ CAMx grid



December 22,1999 12:00:00
Min= 272.6 at (86,71), Max= 276.7 at (87,55)

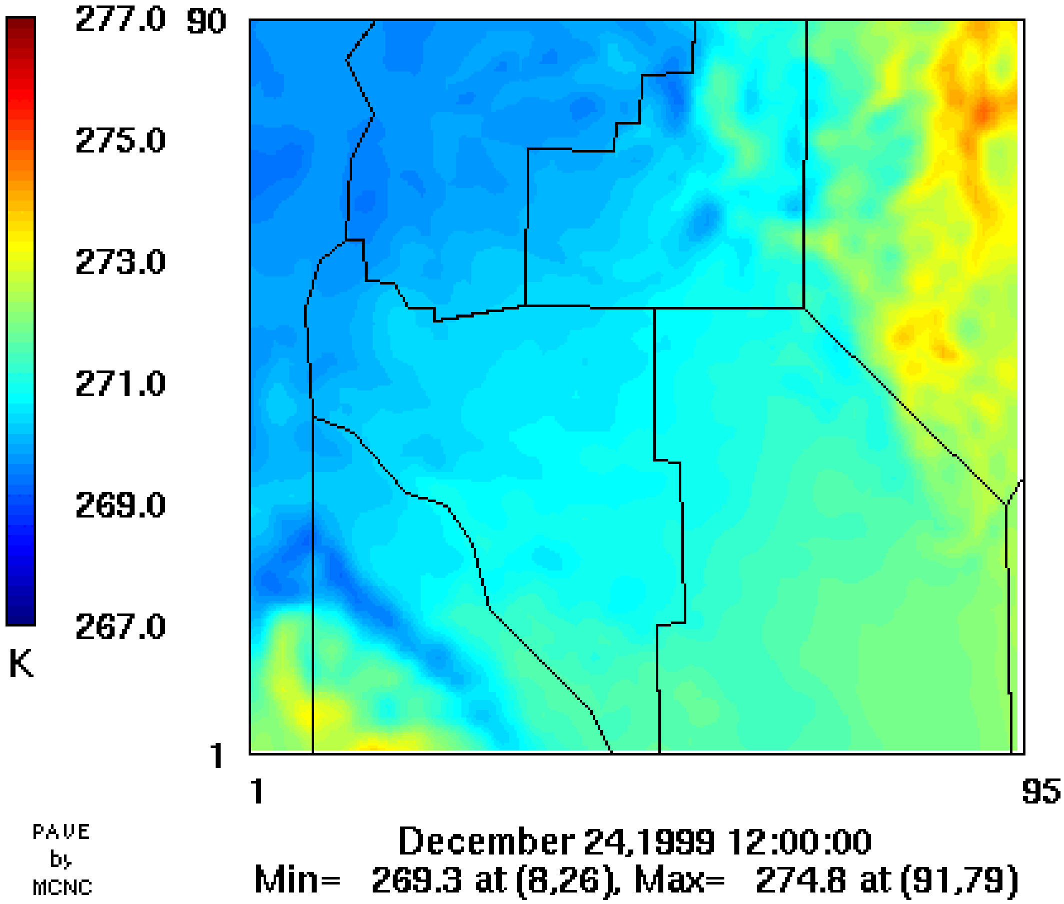
Layer 1 Temperature Field

MM5-based run 4 temperature field on the IDEQ CAMx grid



Layer 1 Temperature Field

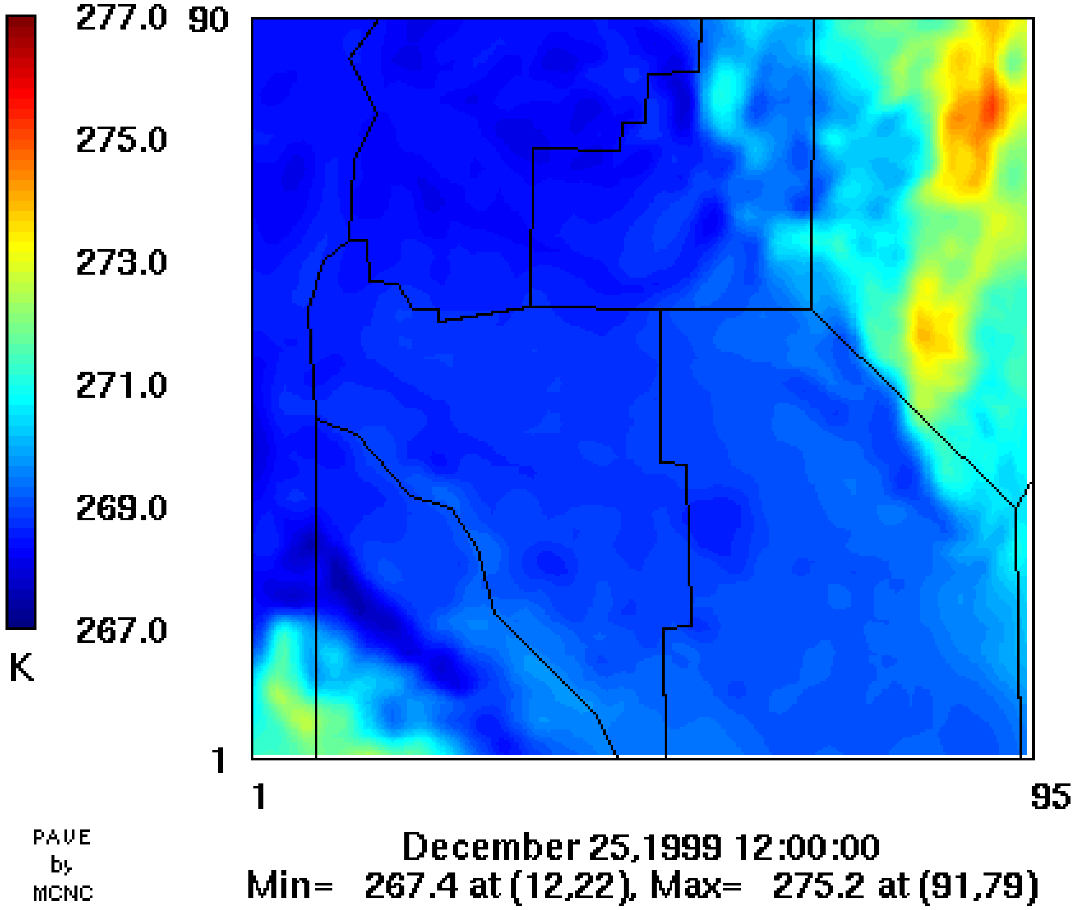
MM5-based run 4 temperature field on the IDEQ CAMx grid



December 24,1999 12:00:00
Min=   269.3 at (8,26), Max=   274.8 at (91,79)

Layer 1 Temperature Field

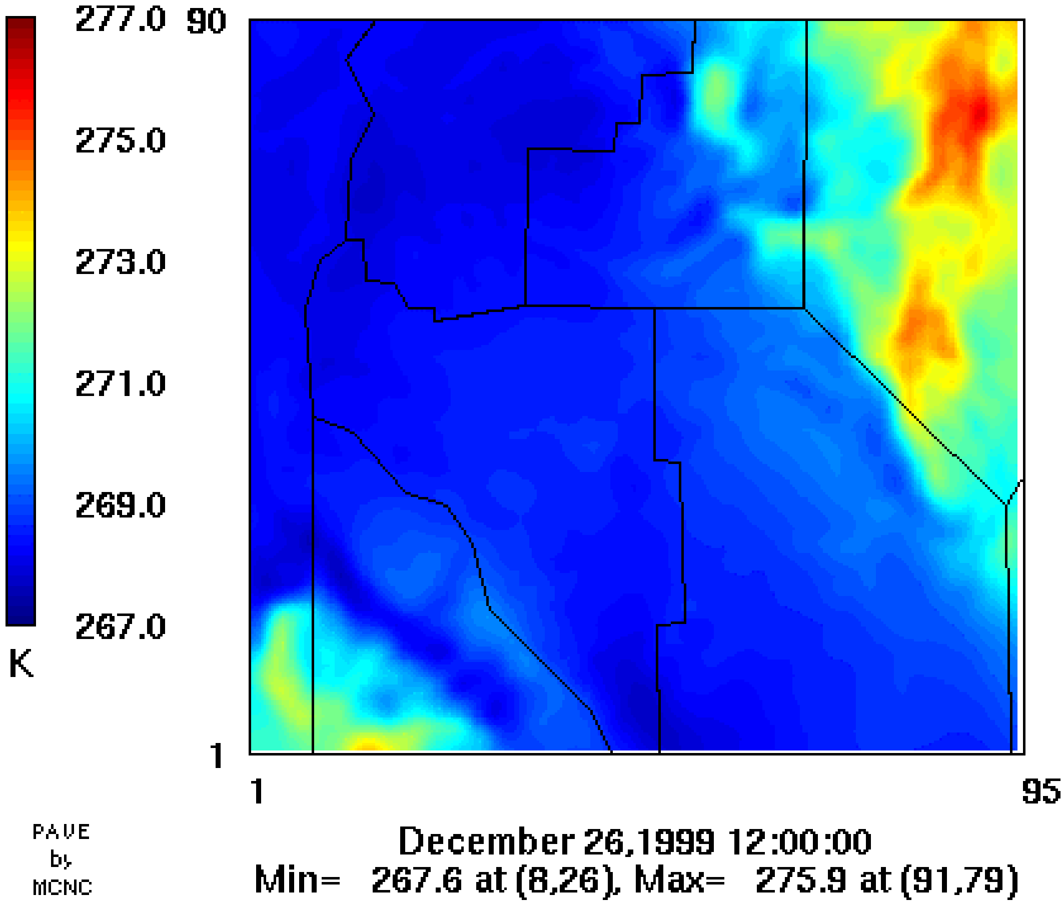
MM5-based run 4 temperature field on the IDEQ CAMx grid



December 25,1999 12:00:00
Min=   267.4 at (12,22), Max=   275.2 at (91,79)

Layer 1 Temperature Field

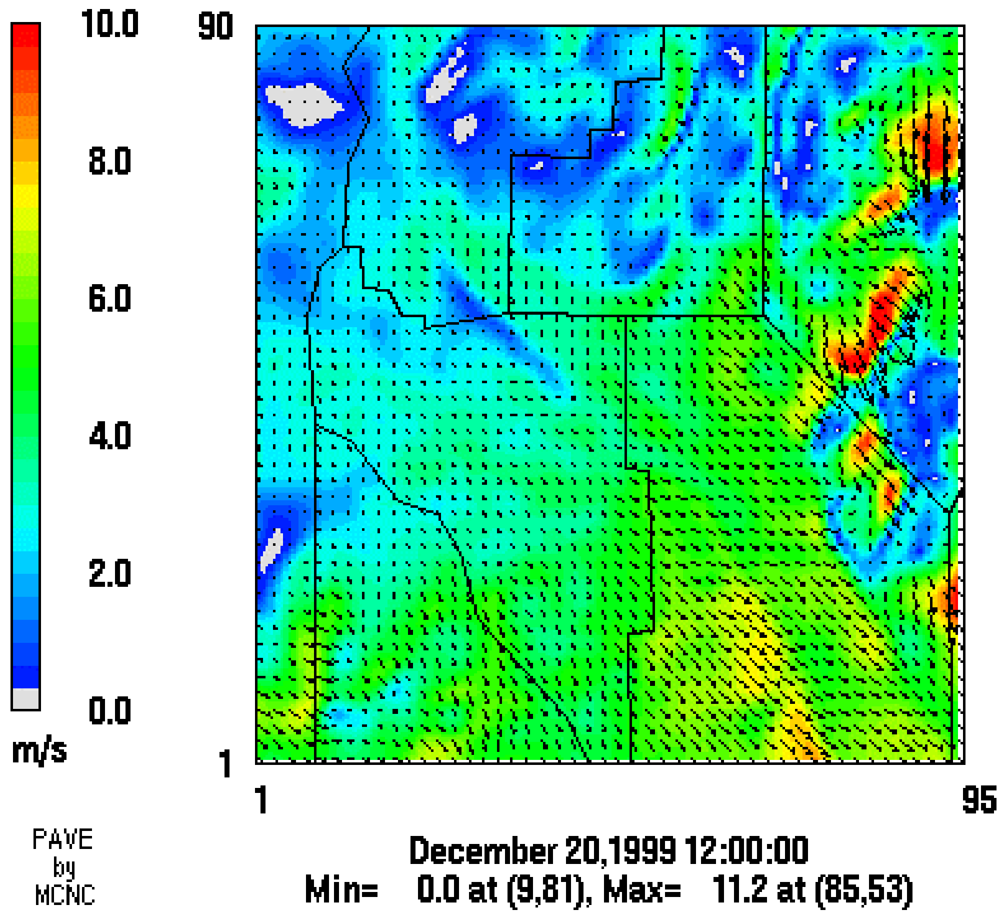
MM5-based run 4 temperature field on the IDEQ CAMx grid



December 26,1999 12:00:00
Min= 267.6 at (8,26), Max= 275.9 at (91,79)

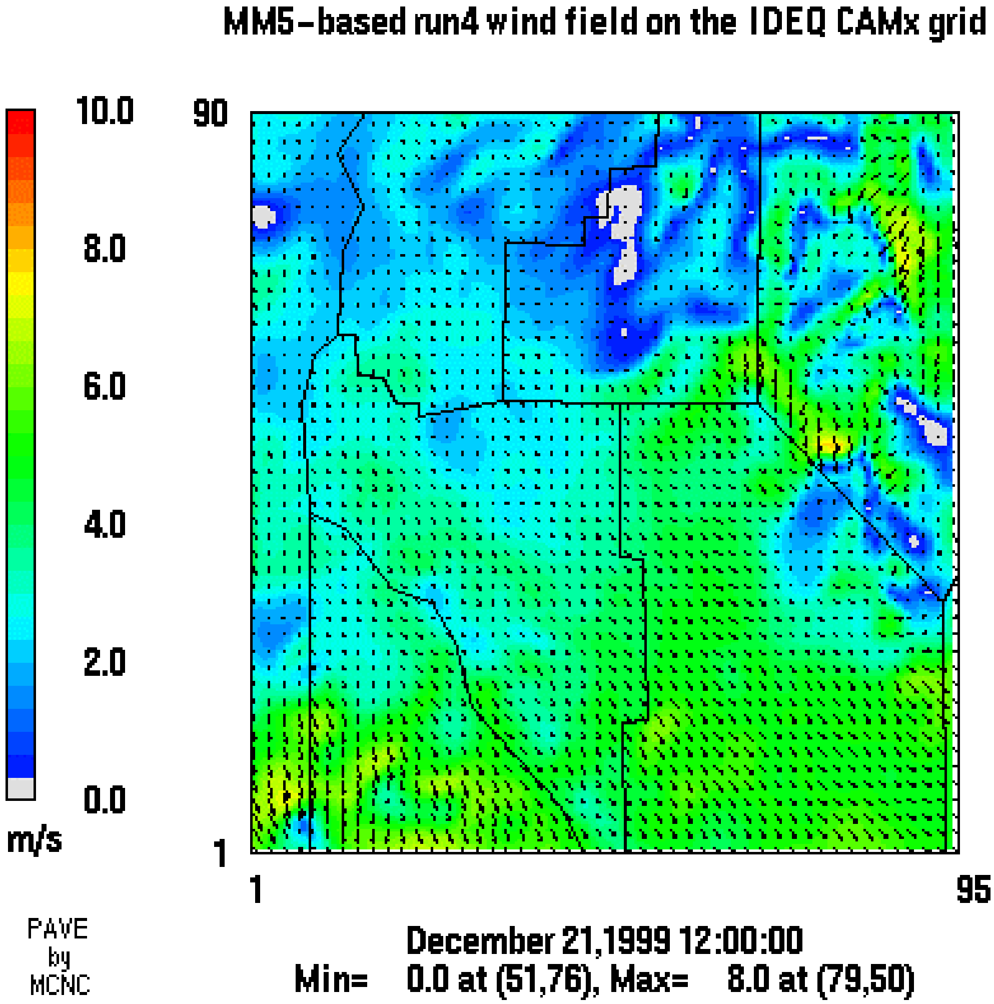
Layer 1 Wind Field

MM5-based run4 wind field on the IDEQ CAMx grid



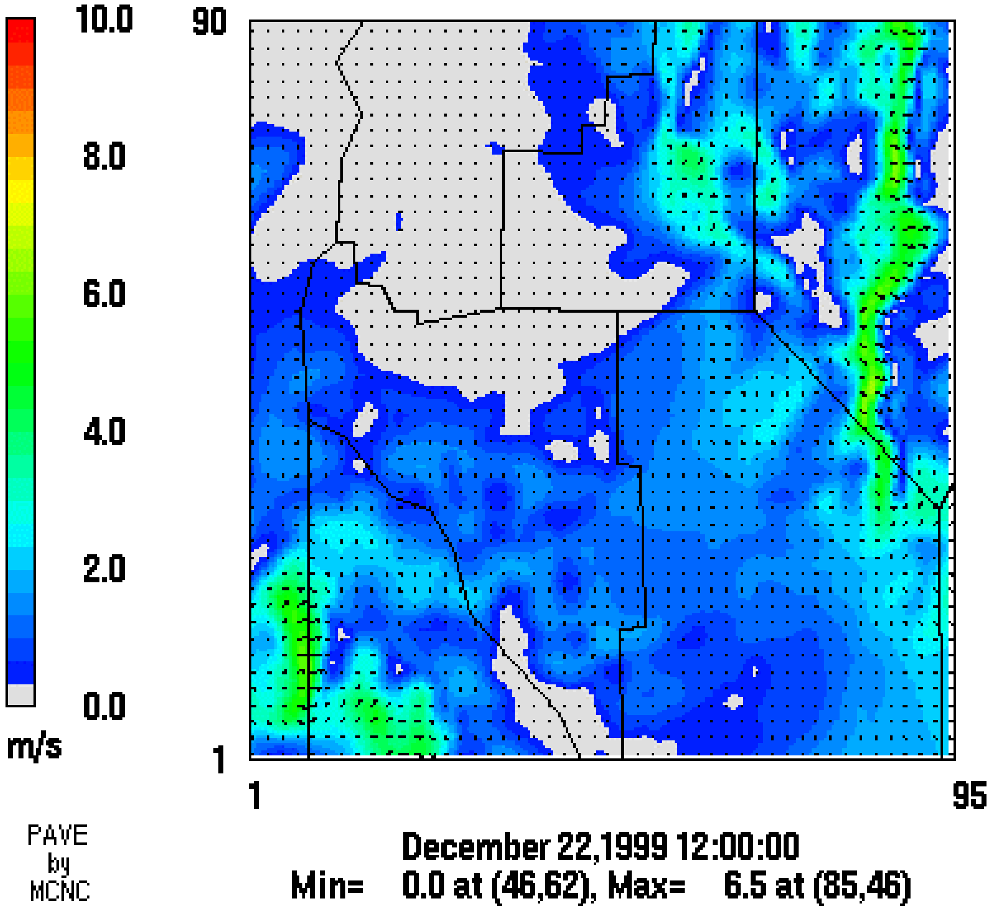
December 20,1999 12:00:00
Min= 0.0 at (9,81), Max= 11.2 at (85,53)

Layer 1 Wind Field



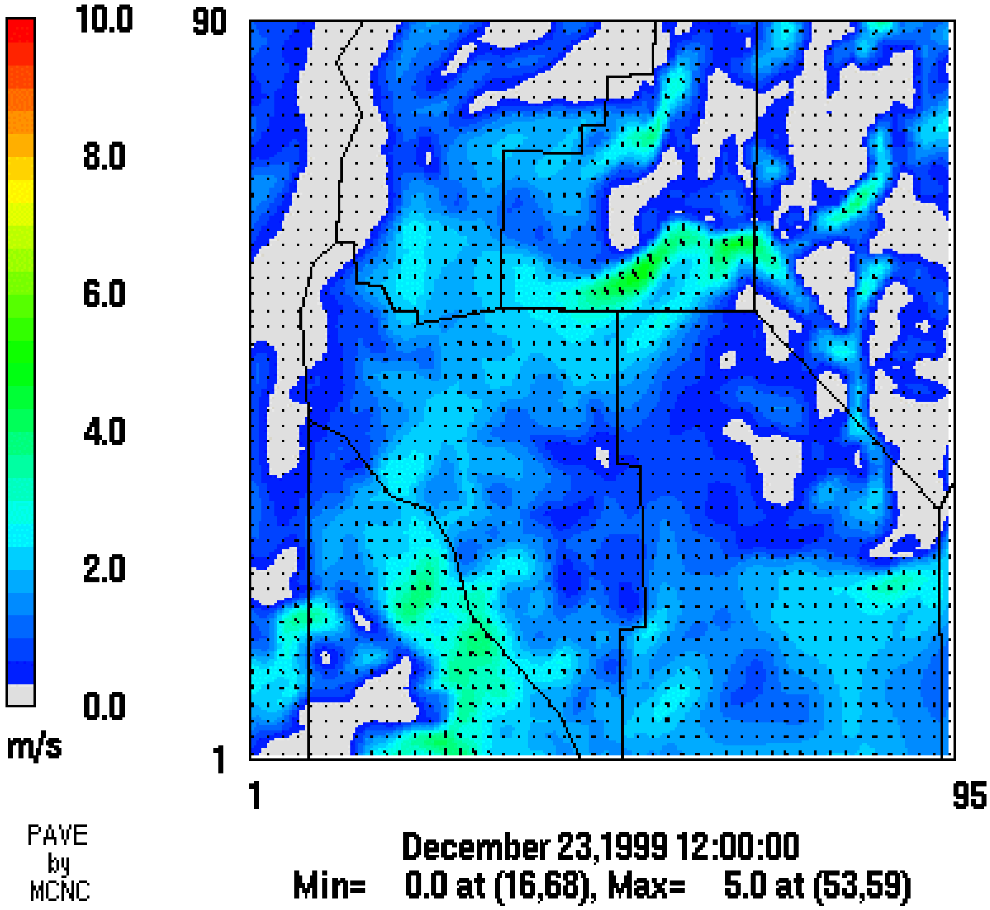
Layer 1 Wind Field

MM5-based run4 wind field on the IDEQ CAMx grid



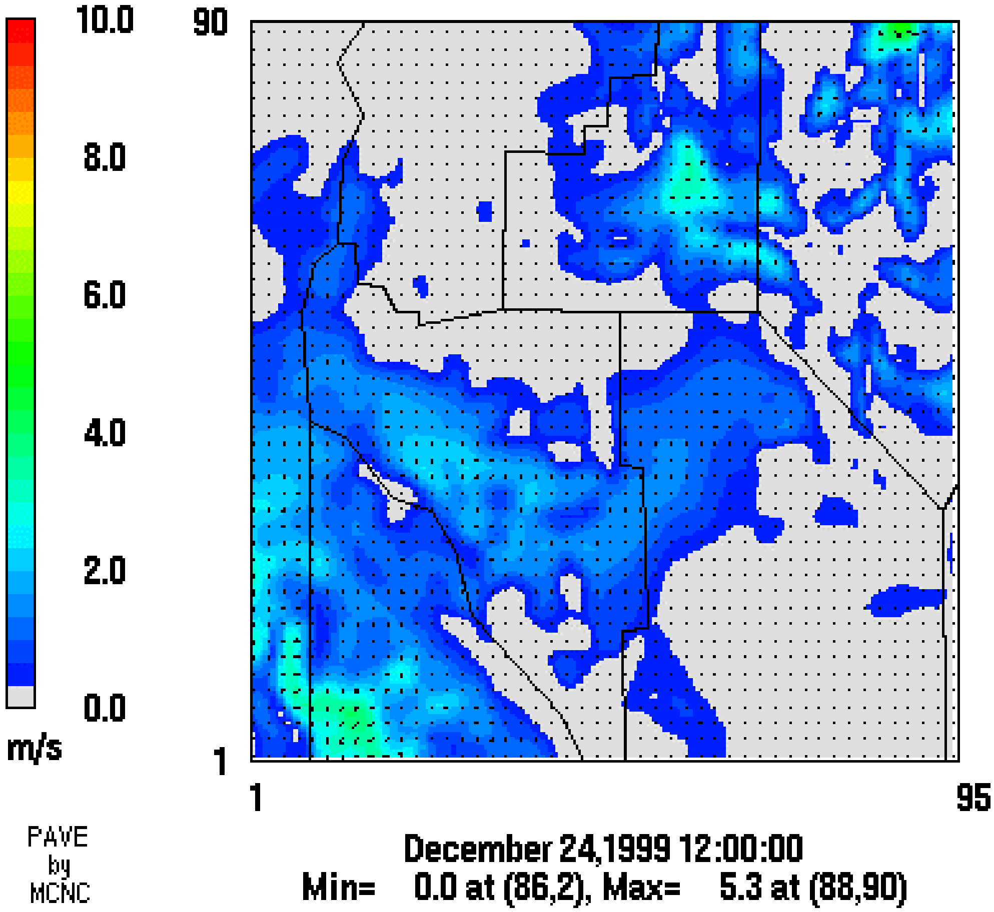
Layer 1 Wind Field

MM5-based run4 wind field on the IDEQ CAMx grid



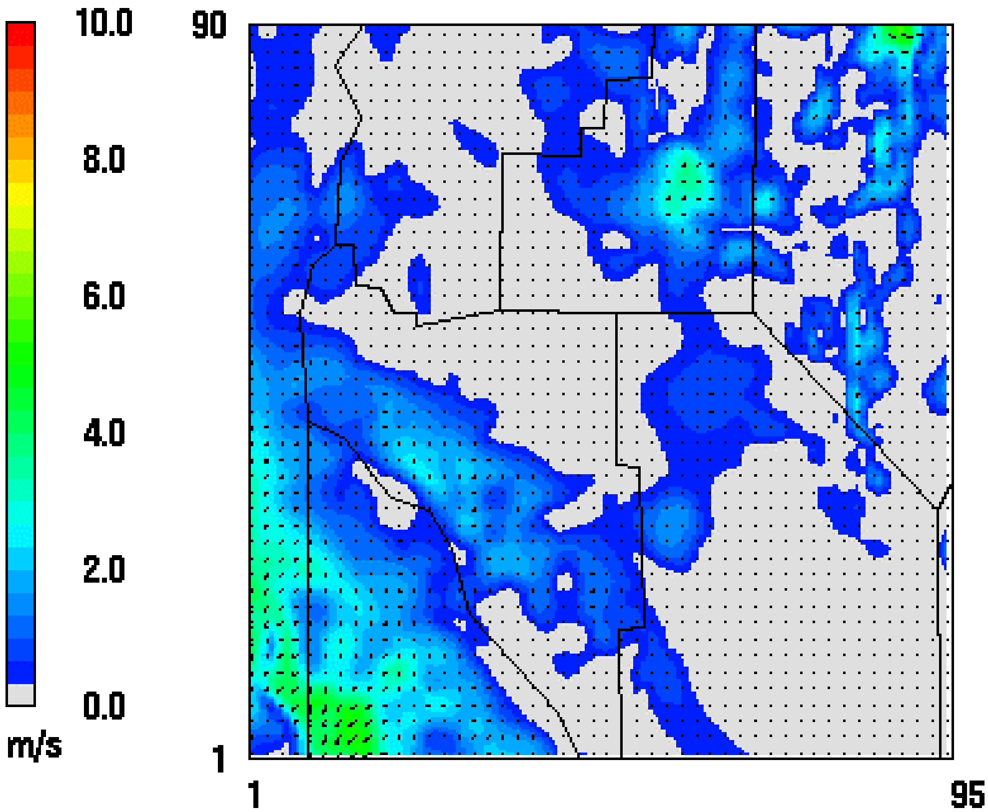
Layer 1 Wind Field

MM5-based run4 wind field on the IDEQ CAMx grid



Layer 1 Wind Field

MM5-based run4 wind field on the IDEQ CAMx grid

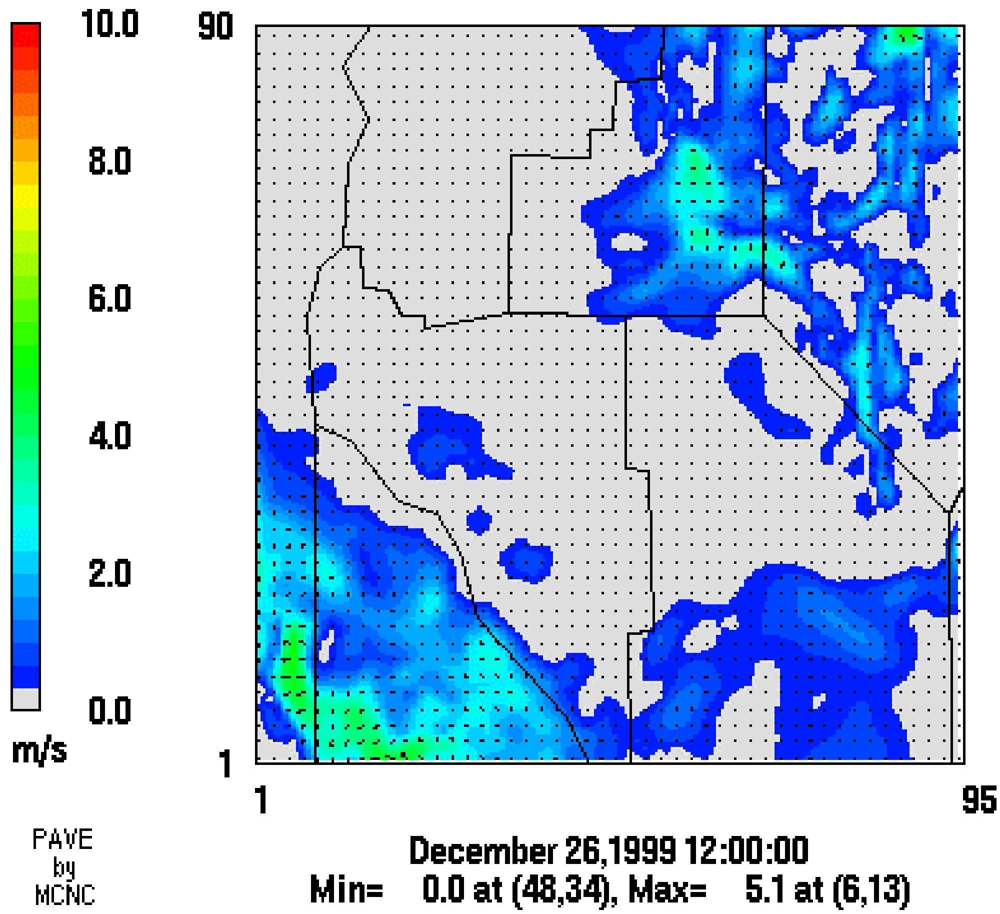


PAVE
by
MCNC

December 25,1999 12:00:00
Min= 0.0 at (29,82), Max= 5.5 at (89,90)

Layer 1 Wind Field

MM5-based run4 wind field on the IDEQ CAMx grid



December 26,1999 12:00:00
Min= 0.0 at (48,34), Max= 5.1 at (6,13)

Appendix D

Revised
Final Report

Development of the
Northern Ada County
PM_{10} Maintenance Plan

Task 3:
Compare Samples to Source Profiles

Receptor Modeling for the
PM_{10} Maintenance SIP

DEVELOPMENT OF THE
NORTHERN ADA COUNTY
PM_{10} MAINTENANCE PLAN

Task 3:
Compare Samples to Source Profiles

RECEPTOR MODELING FOR THE
PM_{10} MAINTENANCE SIP

Revised
FINAL REPORT

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Idaho Department of Environmental Quality
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Boise, ID 83706

May 7, 2002

EXECUTIVE SUMMARY

This report focuses on receptor model source apportionment (Task 3). The general objective of this task was to compare ambient chemistry at the attainment demonstration monitoring site located at the Boise Number 5 Fire Station with source profile chemistry. As such, the CMB results reported here are relevant only to this attainment demonstration monitoring site.

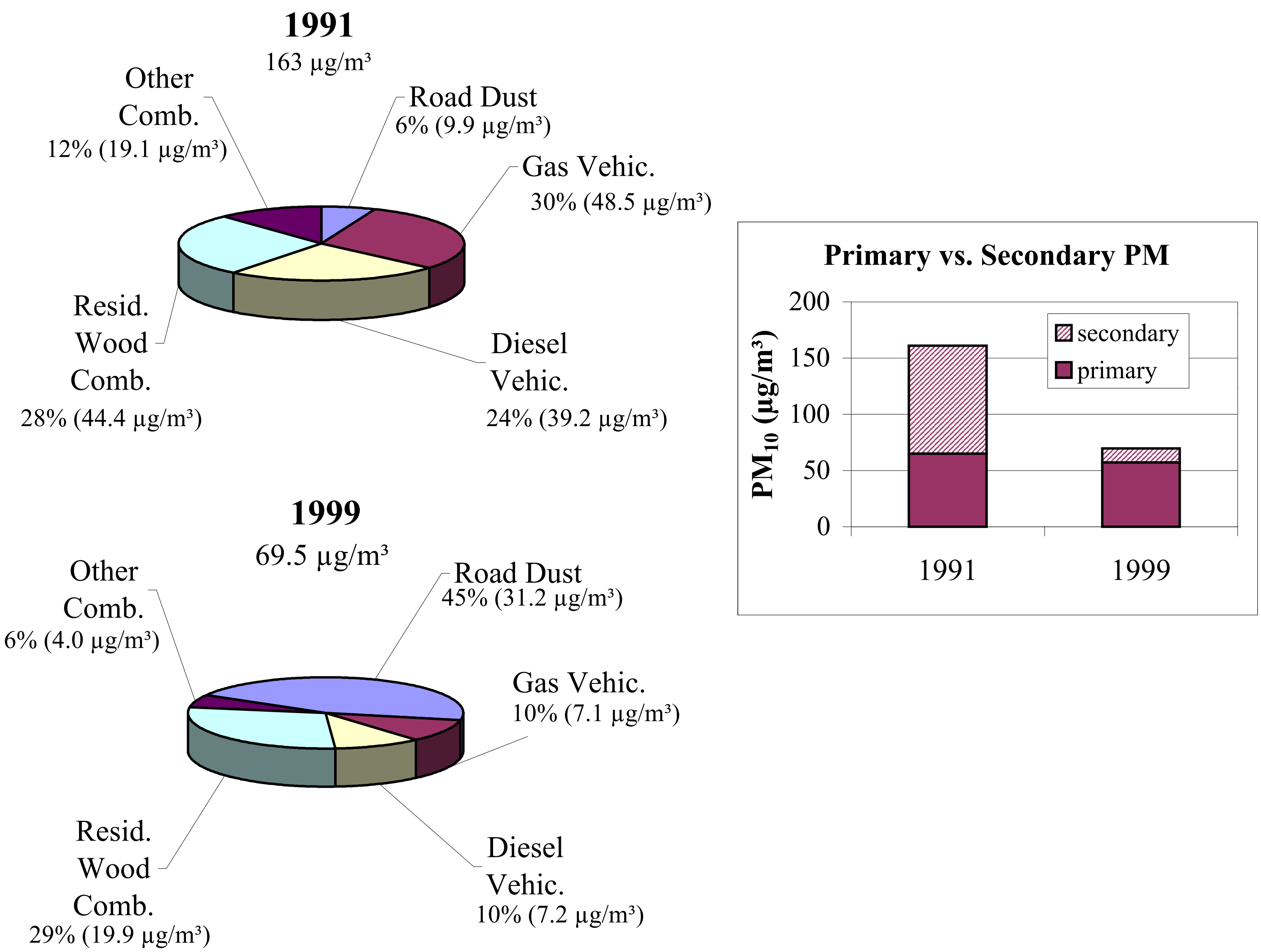
Ambient and source profiles were compared using a basic CMB model as well as two hybrid models that incorporated aspects of the CMB model and aspects of the emission inventory. Application of these models indicated that on the two highest PM_{10} episode days at the Boise Number 5 Fire Station, emissions from gasoline powered vehicles, diesel powered vehicles and wood combustion were responsible for about equal portions of the PM_{10} mass and together accounted for 82% of the mass as indicated in Figure ES1. Other combustion sources and road dust accounted for 12% and 6%, respectively. Secondary PM species were responsible for about 60% of the PM_{10} mass on these two high PM_{10} episode days in 1991.

The PM_{10} mass, its chemistry and source contributions to the two highest study days in 1999 were not representative of PM_{10} episode days, but provide substantial variability with which to test and evaluate dispersion model applications. December 25, 1999, the lowest PM_{10} day during 1999 study period, was similar to the 1991 PM_{10} episode days in that the secondary PM_{10} component accounted for 50% of the PM_{10} and road dust accounted for 6% of the mass. On this day, about 10% of the NOx and about 90% of the SOx were converted to nitrate and sulfate, respectively.

Model and statistical analysis results indicate that PM_{10} concentrations measured at the Boise Number 5 Fire Station monitor are dominated by well-mixed primary and secondary precursor emissions from area and mobile sources in the general area of the monitor. Based on these conclusions, future PM_{10} impacts should be proportional to the ratio of future emission inventories relative to the emissions during the winter of 1991, assuming similar meteorology to the two highest 1991 PM_{10} episode days and similar conversion fractions to those measured on December 25, 1999. Future attainment under worst-case meteorological conditions could be shown by demonstrating control of emissions from these specific source categories.

Impacts from industrial sources were estimated to be less than 0.5 $\mu g/m^3$ or less than about 1% on these high PM_{10} days.

Figure ES.1 Comparison of CMB-EIS SCEs For Two Highest PM_{10} Days in 1999 Study Period With Two Highest PM_{10} Episode Days in 1991



Note: These CMB results are applicable only to the attainment demonstration monitoring site located at the Boise No. 5 Fire Station.

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1.0 INTRODUCTION

This is the third report focused on receptor model source apportionment and model reconciliation. The first two reports dealt with a study plan and source profiles for Chemical Mass Balance (CMB) receptor modeling. The objective of this report is to present and discuss the results from receptor modeling and model reconciliation, Tasks 3 and 4.

The general objective of Task 3 was to compare ambient chemistry with source profile chemistry. The primary tool used to accomplish this task was a basic CMB receptor model. Although this model worked well for primary PM_{10}, it was unable to apportion secondary species and typically was unable to resolve key carbonaceous sources. Other models were used to apportion these latter sources and to confirm primary PM_{10} source impacts. This reconciliation process not only improved source resolution, but also improved the level of confidence in the reconciled source contribution estimates (SCEs).

The receptor modeling approaches used are discussed in Section 2, which is followed by a section on the database. The modeling results are presented and discussed in Section 4. Section 5 discusses model reconciliation as it pertains to the CMB model results.

The results from this modeling effort are applicable only to the attainment demonstration monitoring site located at the Boise Number 5 Fire Station.

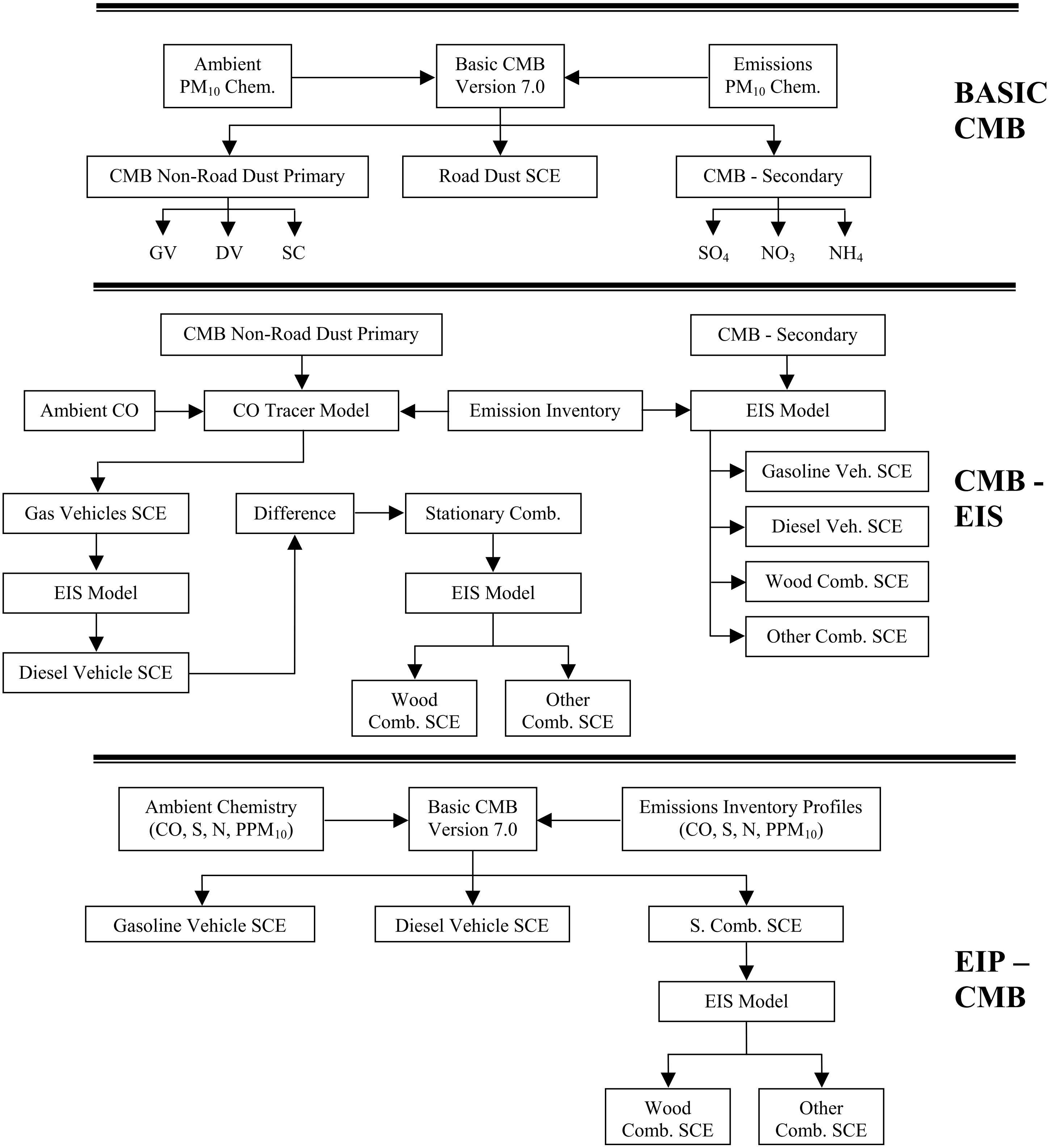
2.0 RECEPTOR MODELING

2.1 Overview

Receptor modeling source apportionment approaches are based on a comparison of source characteristics with measurements made at a receptor (monitoring site). The results from this type of modeling represent the most probable source contributions to modeled pollutants. Because the model results are bound by actual receptor measurements, typical uncertainties for major source categories are on the order of 10 to 30% when they can be resolved from other interfering sources. In this particular application, resolving impacts of mobile and area sources to both primary and secondary PM categories was difficult. As such, a combination of receptor-oriented approaches was used to resolve and quantify source contribution estimates (SCE) as illustrated in the modeling flow diagram shown in Figure 2.1.

A basic Chemical Mass Balance (CMB) receptor model was the primary tool used to apportion ambient PM_{10} concentrations. EPA Version 7.0 of the CMB model was used (EPA, 1990) to apportion primary road dust, wood smoke, vehicle exhaust and secondary species. This method is based on direct measurement of the chemical composition of ambient PM_{10} mass. The relative apportionment of these chemical species between potential sources is based on a statistical comparison of a chemical profile or "fingerprint" of each source category with the chemical profile of an ambient particulate sample. With this "fingerprinting" approach, impacts are based on retrospective measurements of samples selected from a specific period. Results represent the most probable quantitative source impacts for each specific sample selected. However, this basic CMB model was unable to apportion the secondary components of PM_{10}, and was generally unable to effectively resolve impacts from such major source categories as mobile exhaust and combustion sources. As such, a CO tracer, emission inventory-scaling (CMB-EIS) model was used to further apportion the CMB residual components of PM_{10} to gasoline vehicles (GV), diesel vehicles (DV), wood combustion (WC) and other combustion (OC) source categories. A hybrid emission inventory profile CMB model (EIP-CMB) was also used to independently apportion the PM_{10} on the three 1999 study days for which CO, NO_x, SO_x, and PM_{10} data were available. Details and sample calculations for the CMB-EIS modeling approach to source apportionment are presented in Appendix A.

Figure 2.1 Receptor Modeling Approaches Used to Apportion Boise, ID PM_{10}



2.2 The Chemical Mass Balance Method

2.2.1. Theory

The relationship between particulate emissions and ambient particulate concentrations measured at a receptor (pollutant sampler) site distant from an emitting source is a complicated one. Many variables, primarily meteorological, make the direct correlation between source emissions and ambient concentrations a poor one. Each of these variables is random in nature, will vary with space and time, and may combine with other variables in a nonlinear manner. Thus, any estimation of source contribution to ambient particles based on emissions and meteorology is approximate at best. However, the CMB receptor-oriented model is a comparatively simple "model" based on physical principles, which can be used to determine the average contribution of specific source categories to ambient particulate levels. This model is based on the conservation of relative aerosol chemistry from the time a chemical species is emitted from its source to the time it is measured at a receptor. That is, if p sources are emitting M_j mass of particles, where m is the total mass of the particulate collected on a filter at a receptor site, the model assumes the mass on the filter is a linear combination of the mass contributed from each of the sources.

The mass of a specific chemical species, m_i, is given by the following:

$$m_i = \sum_{j=1}^{p} M_{ij} = \sum_{j=1}^{p} F_{i'j} \quad M_j \qquad (1)$$

where M_{ij} is the mass of element i from source j and $F_{i'j}$ is the fraction of chemical species i in the mass from source j collected at the receptor. It is usually assumed that:

$$F_{i'j} = F_{ij} \qquad (2)$$

where F_{ij} is the fraction of chemical i emitted by source j as measured at the source. The degree of validity in this assumption depends on the chemical and physical properties of the species and its potential for atmospheric modifications such as condensation, volatilization, chemical reactions, sedimentation, etc.

If we accept this equation, however, and divide both sides of Equation 1 by the total mass of the deposit collected at the receptor site, it follows that:

$$\frac{m_i}{m} = \sum_{j=1}^{p} F_{ij} \frac{M_j}{m} \qquad (3)$$

or,

$$C_i = \sum_{j=1}^{p} F_{ij} S_j \qquad (4)$$

where C_i is the concentration of the chemical component i measured at the receptor and S_j is the source contribution, i.e., the ratio of the mass contributed from source *j* to the total particulate or lead mass collected at the receptor site. In practice, it is this fraction of particulate pollution measured at a receptor due to source *j*, S_j, which is of primary interest in receptor modeling calculations.

If the C_i and the F_{ij} at the receptor for all *p* of the source types suspected of affecting the receptor are known, and $p < n$ (n = number of chemical species), a set of *n* simultaneous equations exists from which the source type contributions S_j may be calculated by least squares methods.

2.2.2. Application of the CMB Modeling Method

EPA's latest version of the CMB model, Version 8.2 (CMB 8.2, a Windows based version), is currently in beta testing and has not yet been approved for general application. (Coulter, 2001). Version 7.0 (EPA, 1990) was used for this application. The CMB receptor modeling was performed in a manner consistent with EPA's *Protocol for Applying and Validating the CMB Model* (EPA, 1987c).

The CMB procedure begins with a set of linear equations, which express the ambient concentrations of chemical species measured at an ambient receptor site as the sum of products of source compositions and source contributions. This set of equations is over-determined (more than one possible solution) because the number of chemical species exceeds the number of contributing source types. The source contributions are the unknowns in these equations. However, a unique solution cannot be found for this set of equations because measurement uncertainty precludes determination of exact values for source and receptor data. When these uncertainties are estimated for both source and receptor measurements, additional physical constraints are applied which yield a most probable solution. This solution minimizes the difference between calculated and measured receptor concentrations by using an effective-variance weighting scheme. The weighting has a physical significance in that it is derived from the measurement uncertainties of both source and receptor chemical species. (Species with higher relative concentration uncertainties carry less weight in the regression than species with lower relative uncertainties.) Although the CMB solution is similar to some statistical inference methods, it is not dependent on statistical principles. The basic model equations, (which represent the source-receptor relationship) the effective variance weighting, and the error propagation are all based on physical principles.

The CMB provides a Source Contribution Estimate (SCE) and associated standard error uncertainty (STD ERR) for each source category. The model produces these estimates by making an effective-variance weighted least squares fit between the chemical composition of the ambient sample and the composition of the sources. It estimates what amounts of each source (the SCEs) will collectively best explain the chemical composition of the ambient sample.

There are five basic data types necessary for CMB modeling:

- Source category names;
- Chemical composition or profile to be associated with each source category;
- Uncertainty in the chemical composition of each source category;
- Chemical composition of the ambient particles sampled at a receptor; and
- Uncertainty in the receptor chemical composition.

The ability of the CMB model to achieve a proposed set of apportionment goals is determined before the data is entered into the computer. In other words, the chemical composition of the source profiles and ambient aerosol chemistry are established before the model is applied. At the time of data entry, the only options available are the selection of source profiles and the source category names to associate with the profiles.

There are four major steps involved in applying the CMB receptor model to an existing database:

- Determine appropriateness of the application;
- Form input data files;
- Select an optimum model solution for each receptor sample; and
- Verify model results.

The appropriateness of a data set for CMB modeling was determined before the CMB model was applied. There are no quantitative rules for determining data appropriateness. However, the EPA suggests using the following criteria as a guide (EPA, 1987c), which was done in this application:

- Although the model can be applied to a single sample, an adequate number of samples need to be available and included to represent the area or time period for which conclusions are to be drawn. This was one of the main limitations in this particular application, since none of the 1999 days sampled represented typical historical episodic conditions.
- Species appropriate to the problem must be included in the database and with precision and accuracy's adequate to achieve source apportionment goals.
- Source categories should not be collinear and their chemical compositions must represent the range of variability expected from a number of individual emitters in the same source type category. Although some sources were collinear and not resolvable, their SCEs were determined with emission inventory scaling type modeling.

- Source profiles should be representative of the emissions, as they would arrive at the receptor.
- The number of source categories in a single application must be less than the number of species included in the regression.

Once it was determined that application of the CMB model was appropriate, it was applied at varying levels of complexity. The EPA arbitrarily separates these into three levels. Level I uses existing data or data that can easily be obtained from analyses of existing samples. Level II involves additional analyses on existing samples or the acquisition of additional samples. Level III is a comprehensive CMB analysis and includes the acquisition of new data from both ambient and source sampling. This application to Treasure Valley was considered a Level I application since existing data was used.

The process of CMB analysis consisted of selecting the optimum solution to the effective variance least squares regression using the following seven steps:

- Assessment of the general applicability of the CMB model to the situation under study;
- Configuration of the model with appropriate sources, source profiles, and chemical species concentrations at receptor sites;
- Examination of model statistics and diagnostics;
- Determination of agreement with model assumptions;
- Identification of problems, changing the model configuration, and rerunning;
- Testing of the consistency and stability of model results; and
- Evaluation of the validity of model results.

Although there was a degree of subjectivity in this selection process, much of the subjectivity was removed when the fitting protocols and goodness-of-fit statistical criteria recommended by the EPA are used.

The first step was to include all the sources or representatives of all source categories and all defined key species in the initial CMB analysis. Examination of the statistical goodness-of-fit criteria resulting from this initial analysis was used to evaluate the quality of the source contribution estimates. Based on this examination, a different set of sources and species was selected and evaluated. This stepwise procedure continued until, based on the following criteria, an optimum fit was obtained:

- Percent mass explained was close to 100%;
- R-square was close to 1;
- Chi-square was minimized;

- T-statistic was greater than 2;
- Source uncertainty clusters were minimized;
- Calculated-to-measured species ratios were close to 1;
- Ratios of R/U were close to 0; and
- Degrees of freedom were maximized.

These criteria are defined and described in Table 2.1

An example of a CMB model report is illustrated in Table 2.2. The CMB modeled results for each period modeled are presented in Appendix B. These reports provide three primary outputs: the contribution estimates to ambient concentrations of the sources or source categories which are included in the fit (SCE), the standard errors of these SCEs (STD ERR), and the species concentrations calculated from the fit (CALC).

The model provides three statistical measures, which were used to evaluate how well the model's calculated species concentrations match the ambient measurements for these species. These statistics are the percent of total mass explained by the fit (% MASS), R-SQUARE, and CHI-SQUARE. It is generally desirable to obtain a good fit of the data based on these three measures while obtaining SCEs with low STD ERR relative to the size of the SCE.

The model provides four diagnostics to help identify data responsible for a poor fit so that improved data might be obtained or included to rectify the situation. These are the uncertainty/similarity clusters (U/S CLUSTERS), the ratio of calculated to measured species concentrations (RATIO C/M), the ratio of the residual (calculated minus measured) to the uncertainty of this difference (RATIO R/U), and the portion of a calculated species concentration that is attributed by the model to each source (SSCONT). The latter diagnostic was not included on the standard CMB printout.

Table 2.1 CMB Model Statistical Parameters

Parameter	Abbreviation	EPA Target	Explanation
Std. Error	STD ERR	<SCE	The standard error of the SCE.
T-statistic	T-STAT	> 2.0	The ratio of the value of the SCE to the uncertainty in the SCE. A T-STAT greater than 2 means that the SCE has a relative uncertainty of less than 50%. T-STAT = SCE/STD ERR
R-square	R-SQUARE	0.80 to 1.00	A measure of the variance of the ambient concentration explained by the calculated concentration. The target range is 0.8 to 1.0, where an r-square of 1.0 is perfect.
Chi-square	CHI-SQUARE	0.0 to 4.0	A term that compares the difference between the calculated and measured ambient concentrations to the uncertainty of the difference. A perfect fit has a chi-square of 0, and a chi-square less than 2 usually indicates a good fit. The target range is 0.0 to 4.0.
Percent Mass Explained	% MASS	100% " 20%	The ratio of the total calculated to measured mass. The target range is 80% to 120%. **%** MASS = M_c/M_m X 100%
Degrees of Freedom	DF	> 5	The difference between the number of fitting species and the number of fitting sources. This value must exceed 1 and should be greater than 5.
Uncertainty/ Similarity Clusters	U/S CLUSTERS	None	A list of sources that were not sufficiently resolved by the CMB analysis. No clustering is preferred.
Ratio of Calculated to Measured	RATIO C/M	0.5 to 2.0	The ratio of the calculated to measured concentration of an ambient species. Ideally, this value should be 1.0, but the target range is 0.5 to 2.0. RATIO C/M = C_i/M_i for each species i.
Ratio of Residual to Uncertainty	RATIO R/U	B2.0 to 2.0	The ratio of the residual (calculated minus measured) to the uncertainty of the residual (square root of the sum of squares of the uncertainties). Target range is -2.0 to 2.0.

Table 2.2 Sample CMB 7 Source Contribution Estimate Report

```
SOURCE CONTRIBUTION ESTIMATES -  SITE: BFS5         DATE: 12/25/99    CMB7 33889
 SAMPLE DURATION        24      START HOUR        0         SIZE:    ALL
        R SQUARE       .99    PERCENT MASS      95.9
      CHI SQUARE       .14              DF        23

   SOURCE
      * TYPE     SCE(UG/M3)    STD ERR      TSTAT
 ---------------------------------------------
 1      TVPRD        2.1532       .2363     9.1118
 71     RWBCOMST    15.4800      2.2525     6.8725
 105    AMMON        3.5769       .4049     8.8332
 106    SULFATE      2.5235       .3175     7.9476
 107    NITRATE     11.7357      1.3201     8.8897
 ---------------------------------------------
 SPECIES CONCENTRATIONS -  SITE: BFS5         DATE: 12/25/99    CMB7 33889
 SAMPLE DURATION        24      START HOUR        0         SIZE:    ALL
        R SQUARE       .99    PERCENT MASS      95.9
      CHI SQUARE       .14              DF        23
 SPECIES-------I---MEAS------------------CALC-------------RATIO C/M----RATIO R/U
 C1     TOTAL  T  37.00100+-    .74002  35.46931+-  2.63444     .96+-   .07     -.6
 C11    NA          .03930<    .08030    .00770<    .01231     .20<   .51     -.4
 C12    MG          .00100+-   .00100    .00274+-   .00444    2.74+- 5.22      .4
 C13    AL          .00100+-   .00100    .07366+-   .04036   73.66+-84.00     1.8
 C14    SI          .00100+-   .00100    .31666+-   .16071   *****+-*****     2.0
 C15    P           .00100+-   .00100    .00012+-   .01549     .12+-15.49     -.1
 C16    S           .86660+-   .05057    .86765+-   .08445    1.00+-   .11      .0
 C17    CL     *    .02240<    .03000    .01839<    .00486     .82<  1.12     -.1
 C19    K      *    .08810+-   .02370    .08244+-   .02127     .94+-   .35     -.2
 C20    CA     *    .05350+-   .05170    .04120+-   .00817     .77+-   .76     -.2
 C22    TI     *    .00100<    .05410    .00828<    .00850    8.28< *****      .1
 C23    V      *    .00100<    .02840    .00013<    .01550     .13< 15.96     -.0
 C24    CR     *    .00100<    .00790    .00025<    .01548     .25< 15.61     -.0
 C25    MN     *    .00100<    .00410    .00172<    .00065    1.72<  7.08      .2
 C26    FE     *    .07710+-   .00430    .07731+-   .00710    1.00+-   .11      .0
 C28    NI     *    .00100<    .00210    .00018<    .01548     .18< 15.49     -.1
 C29    CU          .05160+-   .00390    .00060+-   .00109     .01+-   .02   -12.6
 C30    ZN          .01900+-   .00460    .00534+-   .00527     .28+-   .29    -2.0
 C31    GA     *    .00010<    .00530    .00002<    .01548     .15< *****      .0
 C33    AS     *    .00100<    .00670    .00019<    .00095     .19<  1.58     -.1
 C34    SE     *    .00010<    .00360    .00001<    .01548     .06< *****      .0
 C35    BR     *    .00100<    .00340    .00017<    .00049     .17<   .75     -.2
 C37    RB     *    .00050<    .00340    .00023<    .01548     .46< 31.12     -.0
 C38    SR     *    .00080<    .00410    .00055<    .01548     .69< 19.67     -.0
 C39    Y      *    .00100<    .00450    .00006<    .01548     .06< 15.48     -.1
 C40    ZR     *    .00230<    .00650    .00027<    .01548     .12<  6.74     -.1
 C42    MO     *    .00300<    .01030    .00016<    .00172     .05<   .60     -.3
 C48    CD     *    .00100<    .01850    .00002<    .01549     .02< 15.50     -.0
 C50    SN     *    .00280<    .02710    .00006<    .01551     .02<  5.54     -.1
 C56    BA     *    .00100<    .13830    .00363<    .02672    3.63< *****      .0
 C82    PB     *    .00680<    .01060    .00073<    .00172     .11<   .30     -.6
 C201   OC     *   6.94550+-   .51070   7.63786+-  1.04129    1.10+-   .17      .6
 C202   EC     *   2.75100+-   .17420   1.69535+-   .69393     .62+-   .26    -1.5
 C203   SO4    *   2.59980+-   .15170   2.59980+-   .27876    1.00+-   .12      .0
 C204   NO3    *  11.77460+-   .60160  11.77460+-  1.17522    1.00+-   .11      .0
 C205   NH4    *   3.60830+-   .18340   3.60830+-   .36104    1.00+-   .11      .0
 C219   K2     *    .12210+-   .00630    .12115+-   .19700     .99+-  1.61      .0
 --------------------------------------------------------------------------------
```

There are four main error categories that can impact model performance: incorrect ambient data, incorrect source profiles, incorrect source list, and incorrect profile uncertainty. The existence of these errors can be inferred from the diagnostics and indicators listed above. Possible corrective actions include evaluating ambient and source data, reanalyzing samples, including different sources in the source list, deleting sources from the source list, compositing collinear source profiles, analyzing samples for additional species, etc. After corrective action has been taken, the fit of the measured species data is reevaluated.

After statistically sound and physically reasonable fits were obtained for the ambient samples, the stability of the CMB model results were assessed. This included evaluation of the sensitivity of the model's results to errors in the sources, source profiles, and the ambient data. The final step in the application of the CMB model was verification. In this step, the model results were evaluated for their consistency with available related data (e.g. meteorological, spatial, emissions, and particle size data) and reconciled with other models.

Using the fitting parameters in Table 2.1 and the EPA guidelines, this model application generally resulted in optimized SCEs. The resulting fits were only one of many possible solutions, but it are expected to be the most probable solution. The existence of several different solutions with similar fitting parameters suggests similar probabilities of correctness for each set of source contributions. In such a case, the SCEs of the major sources were generally quite similar.

2.2.3 Verification of CMB Model Results

CMB SCEs represent optimum model solutions for each receptor sample, and are the most probable SCEs. However, the EPA recommends that these results be verified by comparing them to other available information to develop an internally consistent database, which supports the final impact estimates. This concept of model verification is like building a bridge of evidence. The objective is to build a strong bridge of evidence relating source emissions quantitatively to their impacts. The different types of source information can be thought of as analogous to building blocks in a bridge, while the internal consistency of results is analogous to cement holding the building blocks together. Obviously, a strong bridge will be constructed and a high degree of confidence will be achieved when a large amount of internally consistent data is supportive of an estimated source impact. The objective of this verification step is to build a strong, supportive bridge of evidence. As discussed in subsequent sections, some of the information was qualitative while some information like CMB model results are quantitative. To the extent the available information was internally consistent, a higher level of confidence was placed on the results. In cases of inconsistency, the source of the inconsistency was generally identified and corrected.

This receptor model evaluation and verification was based on the consistency of the CMB SCEs with the following:

- Independent model reconciliation
- Validity of model assumptions
- Comparison with alternative CMB fits
- Evaluation of model sensitivity to fitting species and uncertainties
- PM_{10} chemical composition and elemental ratios
- Variability of the chemical composition
- Variability of SCEs with meteorological factors
- Consistency with emission inventory
- Consistency with dispersion model SCEs (part of receptor/dispersion model reconciliation)

2.3 Post-CMB Emission Inventory Scaling Model (CMB-EIS)

Although receptor-measured pollutant concentrations are clearly dependent on a complex set of factors including emissions, dispersion, mixing height, and atmospheric chemistry; for some source categories, meteorological conditions, and species; proportionality between emissions and receptor measurements can be expected to exist to some extent. The degree to which this proportionality exists will depend on the degree to which basic model assumptions are met. The utility of this type of comparison for providing insight into source contribution estimates will depend in part on the magnitude of emission inventory uncertainties, validity of model assumptions and imposed boundary conditions.

According to the emission inventory, the major sources in the airshed surrounding the key attainment-demonstration monitoring site (Boise Fire Station No. 5) are mobile and area sources. As such, most of these emissions originate over a large surrounding area, have similar daily emission cycles and are emitted into a common mixing layer. Thus, emissions from these sources should experience common dispersion and atmospheric chemistry over a typical diurnal cycle, and their relative impacts on PM_{10} concentrations at the monitor should be somewhat proportional to the amount of their emissions.

The CMB-EIS model used here incorporates both a CO tracer model and an emission inventory scaling model to further apportion the non-road dust primary PM_{10} and the secondary PM_{10} defined by the basic CMB model results as illustrated in Figure 2.1. In this approach, it is assumed that the uncertainty in the relative species concentrations within a source category is less than the uncertainty in the relative emissions between source categories. As such, operations involving inter-species apportionment within a source category were performed first, and then EIS apportionment operations between source categories were performed. Furthermore, since the CO emission inventory is dominated by emissions from gasoline-powered motor vehicles (GVs, 90.3 %), it is assumed to be a reasonably good tracer for impacts from this source category.

The first step of this modeling approach was to apportion the primary PM_{10} impact from GVs based on the measured CO concentration at the receptor and the emission inventory ratio of primary PM_{10} to CO. Emission inventory scaling was then used to apportion primary diesel impacts. The impact of stationary combustion sources was determined by subtracting road dust, secondary PM, primary gas vehicles and primary diesel vehicles from total PM. The stationary combustion source impact was then divided into wood combustion and other combustion with simple emission inventory scaling as was also used to apportion the secondary components. A sample calculation is provided in Appendix A.

2.4 Hybrid Emission Inventory Profile CMB Model (EIP-CMB)

The hybrid Emission Inventory Profile CMB (EIP-CMB) model incorporates components of both the emission inventory and the chemical mass balance model to apportion CO, PM_{10}, sulfate and nitrate. Source profiles were developed from source category emission inventories. These source profiles were then used to apportion the ambient concentrations of these species using the same CMB model described above.

A basic assumption of the CMB model is that the relative composition of a source's emissions (source profile) remains constant during transport to a receptor. In this particular application of the EIP-CMB model, the CO is relatively non-reactive and the PM consists of fine combustion particles, which will be slow to separate from the gas-phase species. As such, the relative composition of these two species is expected to be reasonably stable during transport. On the other hand, sulfur dioxide (SO2) and nitrogen oxides (NOx) are reactive precursors of sulfate and nitrate, and are not expected to have constant relative compositions during transport. However, the total sulfur (SO2-S + SO4-S) and total nitrogen (NOx-N + NO3-N) are expected to be reasonably conserving relative to the other two species in these profiles.

Of course, to apply this model, these same species must be measured at the ambient monitoring site. All of these species were measured at the BFS5 on the three study days modeled during the 1999 episode (Kuhns, 00). As such, this model was applied to these three days to provide independent SCEs, and to support the validity of the EIS model.

3.0 DATABASE

3.1 Source Profiles

CMB source profiles were developed from previously published source profile libraries as discussed in a preceding report (Task 2: Determination of Source Profiles). Representative key source profiles considered for basic CMB modeling are summarized in Table 3.1. The road and soil dust samples are representative of the crustal dust source category. Emissions from this source category are rich in crustal elements such as Al, Si, K, Ca, Ti, Mn, Fe and Sr. The category two profiles listed in Table 3.1 are representative of the Motor vehicle category. The dominant species in these emissions are organic and elemental carbon. Although other species are present, their abundance is generally relatively low and do not make major contributions to resolving the impacts from these sources. Similarly, emissions from combustion sources are dominated by carbon species. Other sources are listed in Table 3.1 and a total of over 100 source profiles were considered, but only a few of the mobile and stationary combustion source profiles were identified by the CMB as contributing sources.

The source profiles used in the IE-CMB model are summarized in Table 3.2. These profiles are based on the emission inventory for Ada County developed in Part 2. The profiles for Amalgamated Sugar, gasoline vehicles, diesel vehicles, and stationary combustion are significantly different and were easily resolvable, but only three of the profiles could be included in a single model run because of the limited number of species available. It is important to note that because of the distinctive profile for Amalgamated Sugar emissions, it is possible to eliminate it as a significant contributor to PM_{10} at the BFS5 monitor during high PM_{10} days in December 1999.

3.2 Ambient Chemistry

The 24-hour average ambient chemical composition of PM_{10} for the days modeled is listed for key species in Table 3.3. Further details are provided in Appendix A along with the CMB SCEs.

The most abundant species were carbon compounds, and nitrate, sulfate and ammonium ions. There was little difference between the average chemistry at the BMVS and the BFS5 sites in 1991. There were, however, substantial differences in the concentrations of these most abundant species between 1991 and 1999 averages, even though there were not large differences in the relative concentrations.

Table 3.1 Average Chemical Composition of Representative Key Source Profiles Considered in CMB Modeling

CAT.	DESCRIPTION	ELEMENTAL CONCENTRATION (% PM_{10})																								
		CL	K	CA	TI	V	CR	MN	FE	NI	CU	ZN	AS	SE	BR	RB	SR	ZR	BA	PB	OC	EC	SO4	NO_3	NH_4	$K_{(SOL)}$
1a	Road Dust	1.06	1.53	7.49	0.34	0.03	0.04	0.08	3.73	0.01	0.06	0.19	0.00	0.00	0.00	0.01	0.05	0.01	0.06	0.07	6.13	1.28	0.36	0.04	0.07	0.08
1b	Soil Dust	0.06	1.78	6.61	0.45	0.02	0.01	0.08	4.14	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.04	0.05	1.55	2.00	0.06	0.03	0.01	0.07
2a	Heavy Duty Vehic.-Diesel	0.05	0.01	0.08	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	25.23	64.35	1.12	0.15	0.14	0.07
2c	Light Duty Vehic. - Unleaded	0.16	0.01	0.29	0.01	0.01	0.03	0.01	0.61	0.01	0.02	0.25	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.15	55.92	24.15	3.61	0.15	0.09	0.03
2d	Light Duty Vehic. - Leaded	0.37	0.18	0.23	0.02	0.00	0.01	0.56	0.23	0.01	0.03	0.14	0.04	0.00	3.62	0.00	0.00	0.00	0.01	10.21	26.99	6.88	2.85	0.97	1.05	0.10
2e	Tire Wear	0.43	0.00	0.09	0.11	0.02	0.03	0.05	3.00	0.02	0.02	0.37	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.01	40.08	21.60	0.90	0.08	0.01	0.01
2f	Brake Wear	0.11	0.15	1.39	0.28	0.02	0.03	0.07	27.69	0.04	0.47	0.43	0.00	0.00	0.00	0.00	0.08	0.01	6.35	0.01	7.11	1.67	0.56	0.03	0.00	0.00
3b	Aircraft	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.90	70.10	0.00	0.00	0.00	0.00
4b	Residential Fireplaces	0.48	0.47	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.11	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.13	39.63	24.67	0.15	0.12	0.12	0.09
4c	Res. Wood Burning Stoves	0.44	1.90	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49.26	7.72	0.25	0.06	0.08	0.29
5e	Space Heating - Coal	0.05	0.27	1.16	0.04	0.02	0.00	0.01	0.86	0.05	0.03	0.16	0.02	0.00	0.00	0.00	0.02	0.00	0.06	0.01	54.74	33.04	1.66	0.16	0.70	0.24
6a	Coal-Fired Boilers	0.06	0.11	3.45	0.43	0.00	0.02	0.03	2.92	0.01	0.02	0.08	0.00	0.04	0.01	0.01	0.20	0.02	0.00	0.07	0.00	4.28	10.17	0.00	0.35	0.46
6b	Oil-Fired Boilers	0.03	0.14	0.79	0.06	1.72	0.02	0.02	1.55	2.68	0.04	0.20	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.07	6.30	15.66	39.80	0.45	3.10	0.00
7a	Sewage Sludge	1.48	0.96	5.07	0.44	0.18	0.58	0.21	5.38	0.00	0.88	0.36	0.00	0.15	0.38	0.00	0.00	0.00	0.27	2.94	0.00	0.00	0.00	0.00	0.00	0.00
8a	Wood Products and Manuf.	0.03	0.11	0.39	0.01	0.00	0.00	0.01	0.26	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	43.13	4.55	0.00	0.00	0.08	0.05
9a	Portland Cement	0.00	0.14	46.10	0.14	0.00	0.01	0.03	2.94	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10a	Ammonium Sulfate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72.70	0.00	27.30	0.00
10c	Ammonium Nitrate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	77.50	22.55	0.00
11b	Road Salt	60.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3.2 Chemistry of Key Source Profiles Considered in EIP-CMB Modeling

CODE	MNEMONIC	SO_X-S		NO_X-N		CO		PM_{10}	
		Conc.	Unc.	Conc.	Unc.	Conc.	Unc.	Conc.	Unc.
1	AMSUG	2.319	0.232	1.08	0.11	4.68	0.47	1.00	0.10
2	RWC	0.007	0.002	0.03	0.01	7.19	2.16	1.00	0.30
3	LDMV	0.222	0.044	25	5	1,451	290	1.00	0.20
4	HDDV	0.028	0.006	9.874	1.975	6.59	1.32	1.00	0.20
5	RWCNFRS	0.032	0.003	0.120	0.012	36.12	3.61	1.00	0.20
6	NFRSMOK1	0.077	0.008	0.003	0.000	0.117	0.012	1.00	0.20
7	NFRDEIS1	0.227	0.023	0.008	0.001	0.012	0.001	1.00	0.20
8	NFRHIEM	0.251	0.025	4.20	0.42	541	54.08	1.00	0.20
9	NFRSMOK2	0.074	0.007	1.91	0.19	152	15.17	1.00	0.20
10	NFRDEIS2	0.218	0.022	7.36	0.74	11	1.15	1.00	0.20
11	GASOLINE	0.770	0.220	24.32	2.43	1,376	138	1.00	0.10
12	DIESEL	0.103	0.033	9.79	1.96	6.61	1.32	1.00	0.20
13	ST. COMB.	0.031	0.011	0.43	0.15	7.23	2.20	1.00	0.30

Table 3.3 24-Hour Average Ambient Concentrations Used in CMB

Spec.	BMVS Win. '91 µg/m³	BFS5 Win. '91 µg/m³	BFS5 Dec. '99 µg/m³	BMVS Win. '91 % Avg. PM	BFS5 Win. '91 % Avg. PM	BFS5 Dec. '99 % Avg. PM
Cl	0.141	0.232	0.082	0.117	0.176	0.140
K	0.460	0.730	0.662	0.381	0.554	1.128
Ca	0.423	0.772	0.607	0.350	0.586	1.034
Ti	0.060	0.103	0.068	0.050	0.078	0.115
V	0.003	0.006	0.001	0.003	0.004	0.002
Cr	0.002	0.002	0.001	0.001	0.002	0.002
Mn	0.025	0.037	0.015	0.021	0.028	0.026
Fe	0.541	0.940	0.837	0.448	0.713	1.427
Ni	0.001	0.001	0.001	0.001	0.001	0.002
Cu	0.023	0.041	0.032	0.019	0.031	0.054
Zn	0.047	0.069	0.055	0.039	0.052	0.094
As	0.002	0.002	0.002	0.002	0.001	0.004
Se	0.000	0.000	0.000	0.000	0.000	0.001
Br	0.013	0.017	0.003	0.011	0.013	0.005
Rb	0.002	0.003	0.002	0.002	0.002	0.004
Sr	0.006	0.011	0.010	0.005	0.009	0.017
Zr	0.002	0.003	0.004	0.001	0.002	0.007
Ba	0.004	0.017	0.047	0.004	0.013	0.080
Pb	0.037	0.055	0.009	0.031	0.042	0.016
OC	23.9	23.9	10.6	19.8	18.2	18.1
EC	8.0	8.1	4.4	6.6	6.2	7.5
SO_4	13.2	13.2	2.6	10.9	10.0	4.4
NO_3	25.4	26.0	9.1	21.0	19.7	15.5
NH_4	12.2	11.6	2.7	10.1	8.8	4.7
$K_{(SOL)}$	0.267	0.225	0.159	0.221	0.171	0.270
PM_{10}	121	132	59	100	100	100
CO	NA	5,903	1,812	NA	4,479	3,088
SO_x-S	NA	NA	3.7	NA	NA	6.4
NO_x-S	NA	NA	63	NA	NA	107

NA: Not Available

3.3 Statistical Analysis

Bivariate regression analyses were evaluated for inter-element relationships. The R^2 correlation coefficients for these regressions are listed in Tables 3.4A and 3.4B for data collected at the BFS5 monitoring site during 1991 PM_{10} winter episode days and 1999 winter high PM_{10} days. High inter-element correlations ($R^2>0.9$, bold) were observed for elements commonly associated with road dust such as K, Ca, Ti, Mn, Fe, Rb and Sr. Bivariate regression plots for four of the more significant relationships (K, Ca, Ti and Mn) with Fe are illustrated in Figure 3.1. The high correlation of these elements suggests that a single source is responsible for the variability of these elements. A comparison of ambient elemental ratios with source profile ratios for road dust shown in the bottom of Figure 3.1 strongly suggests that Treasure Valley road dust is the primary source contributing to the ambient concentrations of these elements. Similar road dust elemental relationships were also observed at the Cloverdale monitoring site.

Strong correlations were also observed between CO and Fe (R^2 of 0.87) and between CO and NOx (R^2 of 0.79) as illustrated with the regression plots shown in Figures 3.2 and 3.3. The CO and Fe relationship is internally consistent with the hypothesis that these two species are dominated by a common source such as gasoline powered motor vehicles. The high degree of correlation between the CO and NOx also indicates that common meteorology and a single source dominate the variability of these two species.

The slope of this regression curve and the CO to NOx ratios listed in Table 3.5 are also consistent with a dominant mobile source contribution to these two species. Based on the emission inventory for Ada county and the relationship with Fe, the CO and NOx relationship suggests that most of the NOx is from mobile sources. In addition, the slope of the CO and NOx regression plot is consistent with that expected from mobile sources and that measured along the Wasatch front in Utah (Cooper, 1994). The slope of the regression curve (11.53) suggests a somewhat lower ambient CO to NOx ratio. This, however, may just reflect the use of oxygenated fuels. Typical CO to NOx ratios for diesel exhaust (0.5:1) and wood combustion (50:1) are quite different from that measured.

Figure 3.4 shows four comparisons of PM_{10} sulfate and nitrate measured at the BFS5 monitor during PM_{10} episodes in the winter of 1991 and on high PM_{10} days during the winter of 1999, and on high PM_{10} days at the Boise Mt. View School and Cloverdale monitoring sites. All four of these plots show strong correlations between these two species when averaged over 24 hours (R^2 values range from 0.90 to 0.98). This is somewhat surprising since formation of these two secondary species depend on significantly different formation chemistry. These observed relationships strongly suggests a dominant common source and common meteorological history for these two species and their precursors. The slopes of these regression plots are consistent with the typical nitrate percent of total nitrogen oxides (1 to 5%) and percent sulfate of total sulfur oxides (50 to 80%) formed from their precursor species, if their precursors were dominated by a common mobile source. This type of relationship would not be observed if a single

Table 3.4a. Elemental Correlation Coefficients (R^2) for Boise 24-hour Avg. PM_{10} Samples – 1991

	AL	BR	CA	CL	EC	FE	K	MASS	MN	OC	PB	RB	SR	TI	V	ZN
AL	**1.00**															
BR	0.18	**1.00**														
CA	**0.94**	0.19	**1.00**													
CL	**0.97**	0.14	**0.95**	**1.00**												
EC	0.02	0.00	0.09	0.02	**1.00**											
FE	**0.98**	0.24	**0.95**	**0.95**	0.02	**1.00**										
K	**1.00**	0.15	**0.93**	**0.98**	0.02	**0.97**	**1.00**									
MASS	0.20	0.01	0.25	0.20	0.03	0.24	0.19	**1.00**								
MN	0.86	0.42	0.88	0.81	0.03	**0.93**	0.83	0.30	**1.00**							
OC	0.30	0.05	0.24	0.30	0.11	0.23	0.32	0.00	0.08	**1.00**						
PB	0.62	0.77	0.62	0.56	0.00	0.70	0.58	0.11	0.85	0.00	**1.00**					
RB	**0.96**	0.13	0.85	**0.94**	0.00	**0.93**	**0.97**	0.23	0.79	0.27	0.55	**1.00**				
SR	**0.98**	0.19	**0.98**	**0.96**	0.06	**0.99**	**0.97**	0.25	0.89	0.29	0.64	**0.91**	**1.00**			
TI	**1.00**	0.21	**0.95**	**0.97**	0.02	**0.99**	**0.99**	0.20	0.88	0.28	0.65	**0.95**	**0.98**	**1.00**		
V	0.88	0.18	0.80	0.83	0.00	0.83	0.87	0.05	0.69	0.28	0.54	0.79	0.82	0.87	**1.00**	
ZN	0.82	0.35	**0.91**	0.79	0.09	0.89	0.78	0.24	**0.93**	0.13	0.76	0.69	0.90	0.84	0.68	**1.00**

Table 3.4b. Elemental Correlation Coefficients (R^2) for Boise PM_{10} Samples - 1999

	AL	BR	CA	CL	EC	FE	K	MASS	MN	OC	PB	RB	SR	TI	V	ZN
AL	**1.00**															
BR	ND	**1.00**														
CA	ND	0.19	**1.00**													
CL	ND	0.11	0.11	**1.00**												
EC	ND	0.27	0.27	0.83	**1.00**											
FE	ND	0.21	**0.98**	0.17	0.35	**1.00**										
K	ND	0.15	**0.96**	0.17	0.33	**0.99**	**1.00**									
MASS	ND	0.04	0.23	0.85	0.77	0.33	0.36	**1.00**								
MN	ND	0.19	**0.97**	0.14	0.34	**0.98**	**0.96**	0.28	**1.00**							
OC	ND	0.31	0.26	0.85	0.88	0.35	0.31	0.73	0.31	**1.00**						
PB	ND	0.04	0.07	0.38	0.25	0.09	0.07	0.21	0.07	0.45	**1.00**					
RB	ND	0.07	0.64	0.11	0.17	0.66	0.64	0.18	0.60	0.27	0.38	**1.00**				
SR	ND	0.10	0.78	0.36	0.38	0.83	0.85	0.55	0.76	0.46	0.20	0.58	**1.00**			
TI	ND	0.42	0.88	0.06	0.25	0.87	0.80	0.11	0.88	0.27	0.08	0.59	0.55	**1.00**		
V	ND	0.47	0.02	0.11	0.02	0.01	0.00	0.22	0.01	0.00	0.00	0.01	0.01	0.20	**1.00**	
ZN	ND	0.29	0.89	0.25	0.48	0.89	0.82	0.30	0.89	0.45	0.17	0.60	0.66	0.85	0.02	**1.00**

ND: Not Detected

Figure 3.1 Elemental Relationships for Key Elements Associated with Road Dust

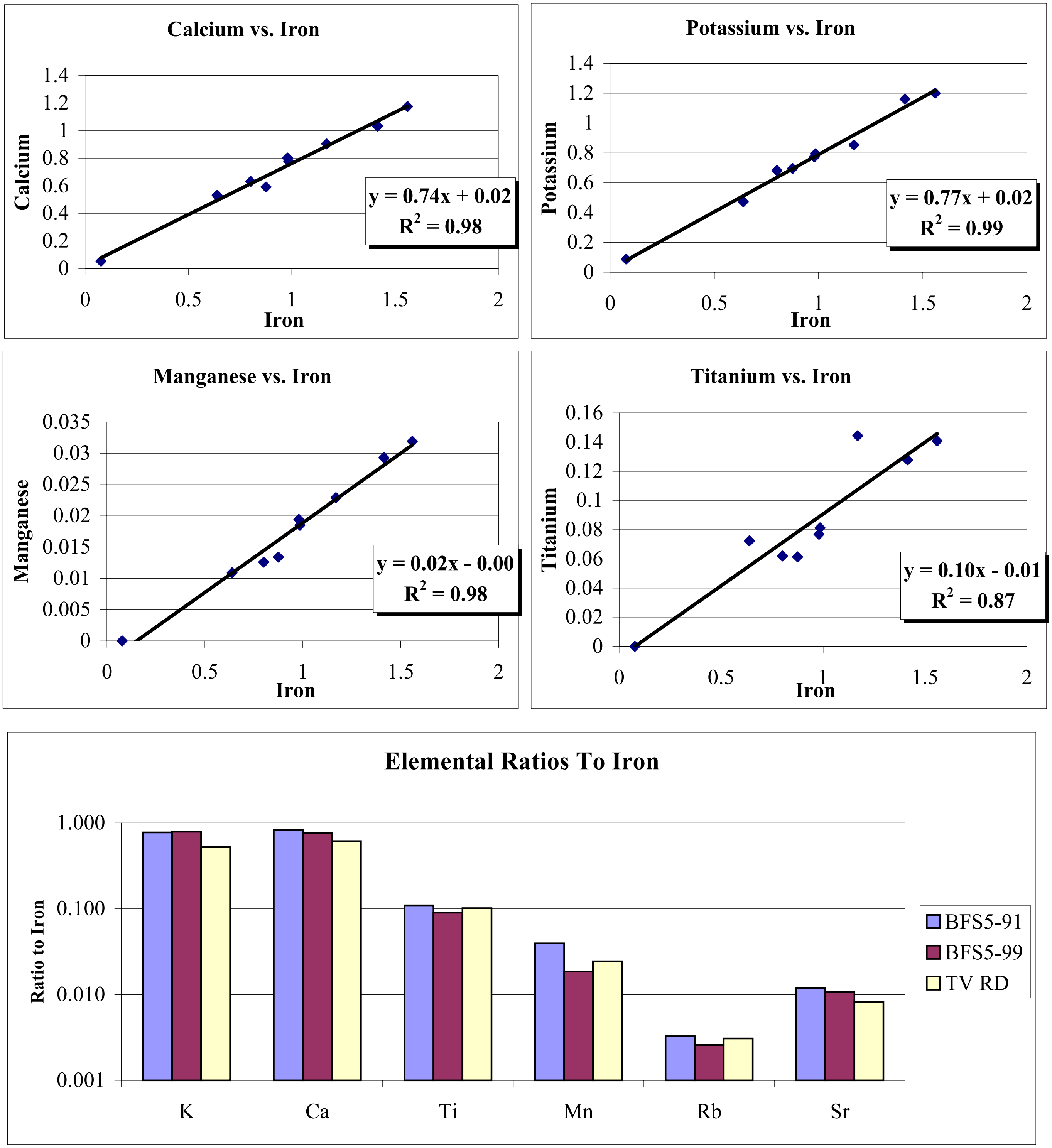


Figure 3.2 Plot of CO Concentration Measured at the Eastman Parking Garage vs. Fe Measured at BFS5 Monitoring Site

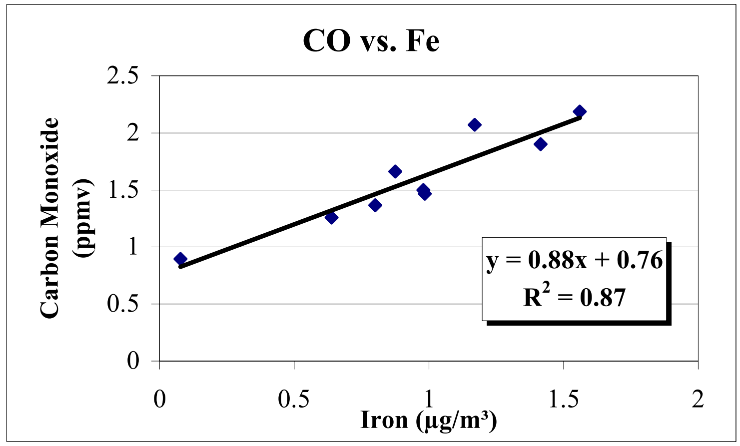


Figure 3.3 Plot of CO Concentration Measured at the Eastman Parking Garage vs. NOx Measured at the BFS5 Monitoring Site

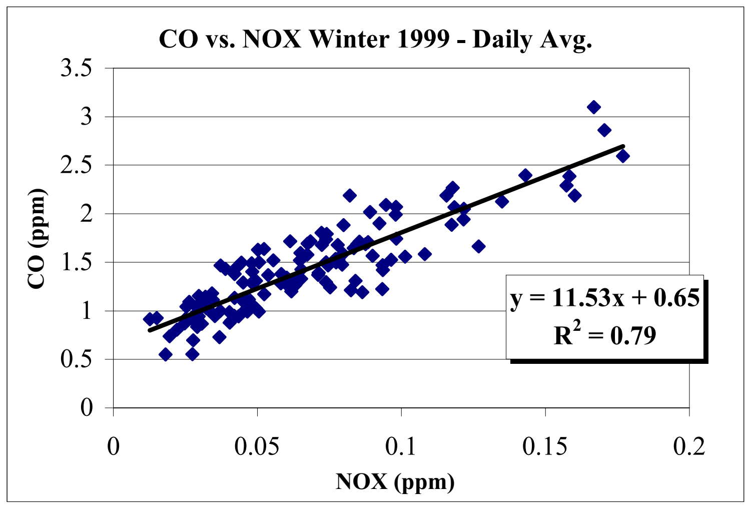


Table 3.5 CO/NOX Ratios

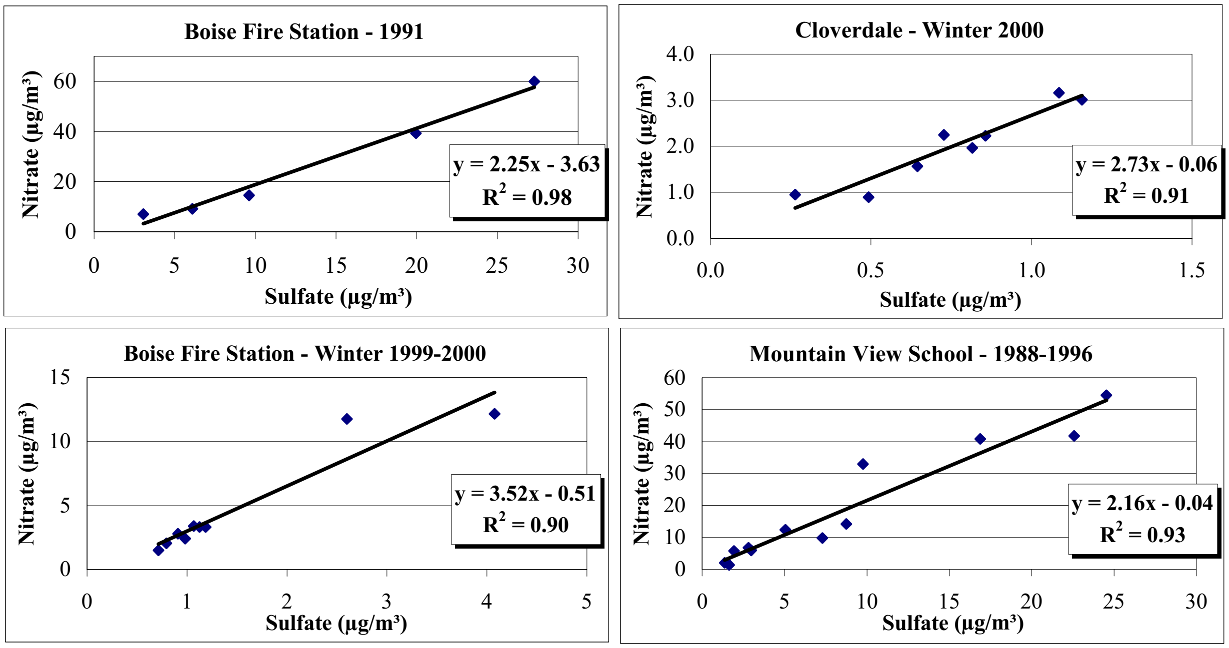
E.I. Source Ratios

Source	Ratio
Amal. Sugar	1.32
Wood Comb.	74.9
Other Comb.	0.48
St. Comb.	3.45
Gas. Vehicles	17.7
Diesel Vehicles	0.23
Mobile	9.13

Ambient Ratios

Period	Ratio
Nov.	17.7
Dec.	23.5
Dec. 22-25	16
Jan.	25.5
Feb.	30.5
March	27.3
Winter 1999	21.4

Figure 3.4 Comparison of 24-hour Average PM_{10} Sulfate and Nitrate Measured at the Boise Fire Station No. 5, Boise Mt. View School and the Boise Cloverdale Monitoring Sites



source like Amalgamated Sugar were a significant contributor to either of these two species. It is also important to note that SO2 concentrations at the BFS5 monitor were about 3 fold greater than that measured at the Cloverdale monitor, and NH3 concentrations at the BFS5 were as much as 70% greater than at the Cloverdale monitor. (Kuhns, 00) This suggests that significant sources for these two species probably exist in the vicinity of the BFS5 monitoring site. These two observations are important because they suggest 1) that there may be a significant urban source of ammonia not previously considered or incorrectly inventoried, and 2) that urban sources are the dominant source of sulfate precursor species impacting the key monitoring site.

3.4 Model Applicability

There are no well-defined rules for determining the appropriateness of a particular application of the CMB model. Although the EPA has suggested criteria as a guide (EPA, 1987c), these guidelines consist of ideal targets for typical applications. These criteria were met for the basic CMB model. However, they were not met for the EIP-CMB model application because of restrictions to available data, lack of episode occurrences during the 1999 intensive study period, and limited resources. However, the primary goal here was to provide SCEs that could be used to optimize a dispersion model for Treasure Valley. In this particular application, filter samples representing both 24-hour average PM_{10} concentrations during the 1999 study period (3 days) and during PM_{10} winter episodes (1991), and two monitoring sites were modeled. In addition, 13 short-term ambient $PM_{2.5}$ data sets were modeled to test the dispersion models ability to predict diurnal variability of PM.

4.0 RESULTS AND DISCUSSION

Source apportionment results for each filter data set modeled are summarized in Tables 4.1 to 4.7. The first two tables summarize results from the basic CMB model. Copies of the final CMB model reports are presented in Appendix B along with the ambient chemistry and goodness-of –fit parameters. Tables 4.3 to 4.6 list the results from the CMB-EIS model. The details of this modeling approach and a sample calculation are presented in Appendix A. Table 4.7 summarizes the results from the EIP-CMB model for the three study days in December of 1999 for which complete data sets were available.

The basic CMB model was only able to resolve source impacts into three general source categories and a secondary species category:

- Road Dust
- Motor Vehicles
- Wood Combustion
- Secondary Species

Road dust was well resolved from impacts of other sources, and the uncertainties in the SCEs for this source category are about 7 to 15%. However, impacts from motor vehicles (gasoline and diesel powered vehicles) and stationary combustion sources such as wood combustion were not well resolved and their uncertainties range from about 15 to 30%. The basic CMB model results are generally consistent with the CMB-EIS model results for primary PM_{10} listed in Tables 4.3 and 4.4. However, the basic CMB primary motor vehicle results are generally lower than the CMB-EIS motor vehicle SCEs. The basic CMB wood combustion results are generally closer to the SCEs reported by the CMB-EIS model. The degree to which they differ, depends in part on whether or not the basic CMB model was able to resolve a motor vehicle source category.

The results are summarized in Tables 4.3 and 4.4 in categories similar to those listed in the emission inventory. Mobile and stationary combustion were the two major source categories. The non-road and industrial point source categories were below the methods quantification limits (impacts were less than uncertainties) of about 0.5 μg/m3 or about 1% of the PM_{10}.

The EIP-CMB results for the three days modeled in 1999 are listed in Table 4.7. The goodness-of-fit parameters for the 24^{th} and 25^{th} of December were quite good, Chi Square of less than 0.15 and percent mass explained greater than 96%, and met EPA fitting requirements for an acceptable model fit. The fit on the 22^{nd} did not meet EPA requirements, primarily because of a poor fit of the sulfur. If the emission inventory source profiles that fit the ambient data so well on the 24^{th} and 25^{th} are representative of the emissions on the 22^{nd} as is likely the case, then the poor fit on the 22^{nd} is probably due to a low reported ambient sulfur concentration on the 22^{nd}.

Table 4.1. Basic CMB Model Results by Major Source Category (µg/m³)

CMB NO.	SITE	DATE	START TIME	DUR.	PM Size	SOURCE CATEGORY (µg/m³)										
						Road Dust (1)	Motor Vehicles (2)	Other Trans. (3)	Wood Comb. (4)	Other Comb. (5)	Boilers (6)	Inciner. (7)	Indust. (8)	Mineral Dust and Proc. (9)	Sec. (10)	Other (11)
1	BFS5	12/22/99	0	24	PM_{10}	38.66	4.51	0.00	21.68	0.00	0.00	0.00	0.00	0.00	4.71	0.00
2	BFS5	12/24/99	0	24	PM_{10}	23.82	0.00	0.00	17.76	0.00	0.00	0.00	0.00	0.00	19.68	0.00
3	BFS5	12/25/99	0	24	PM_{10}	2.15	0.00	0.00	15.48	0.00	0.00	0.00	0.00	0.00	17.84	0.00
4	BFS5	12/22/99	0	5	$PM_{2.5}$	4.56	5.47	0.00	10.83	0.00	0.00	0.00	0.00	0.00	3.34	0.00
5	BFS5	12/22/99	5	5	$PM_{2.5}$	7.06	7.17	0.00	9.46	0.00	0.00	0.00	0.00	0.00	4.97	0.00
6	BFS5	12/22/99	10	5	$PM_{2.5}$	11.90	3.21	0.00	8.88	0.00	0.00	0.00	0.00	0.00	8.72	0.00
7	BFS5	12/22/99	14	4	$PM_{2.5}$	6.53	2.24	0.00	7.28	0.00	0.00	0.00	0.00	0.00	2.79	0.00
8	BFS5	12/22/99	19	5	$PM_{2.5}$	6.07	0.00	0.00	20.93	0.00	0.00	0.00	0.00	0.00	3.72	0.00
9	BFS5	12/24/99	0	5	$PM_{2.5}$	1.47	0.00	0.00	25.41	0.00	0.00	0.00	0.00	0.00	14.12	0.00
10	BFS5	12/24/99	5	5	$PM_{2.5}$	0.00	0.00	0.00	31.92	0.00	0.00	0.00	0.00	0.00	14.19	0.00
11	BFS5	12/24/99	10	5	$PM_{2.5}$	6.22	3.15	0.00	15.65	0.00	0.00	0.00	0.00	0.00	16.29	0.00
12	BFS5	12/24/99	14	4	$PM_{2.5}$	2.50	0.00	0.00	13.96	0.00	0.00	0.00	0.00	0.00	27.10	0.00
13	BFS5	12/24/99	19	5	$PM_{2.5}$	0.00	0.00	0.00	18.37	0.00	0.00	0.00	0.00	0.00	23.10	0.00
14	BFS5	12/25/99	0	10	$PM_{2.5}$	0.00	0.00	0.00	14.58	0.00	0.00	0.00	0.00	0.00	16.66	0.00
15	BFS5	12/25/99	10	9	$PM_{2.5}$	0.00	0.00	0.00	15.48	0.00	0.00	0.00	0.00	0.00	19.87	0.00
16	BFS5	12/25/99	19	5	$PM_{2.5}$	0.00	0.00	0.00	15.77	0.00	0.00	0.00	0.00	0.00	17.72	0.00
17	BFS5	1/4/91	0	24	PM_{10}	11.91	7.06	0.00	43.62	0.00	0.00	0.00	0.00	0.00	77.99	0.00
18	**BMVS**	1/4/91	0	24	PM_{10}	5.88	8.17	0.00	34.58	0.00	0.00	0.00	0.00	0.00	85.01	0.00
19	BFS5	1/7/91	0	24	PM_{10}	7.96	0.21	0.00	55.22	0.00	0.00	0.00	0.00	0.00	113.96	0.00
20	**BMVS**	1/7/91	0	24	PM_{10}	4.44	0.13	0.00	40.32	0.00	0.00	0.00	0.00	0.00	104.42	0.00
21	BFS5	2/1/91	0	24	PM_{10}	70.00	7.12	0.00	15.83	0.00	0.00	0.00	0.00	0.00	11.00	0.00
22	BFS5	12/4/91	0	24	PM_{10}	21.51	0.18	0.00	39.36	0.00	0.00	0.00	0.00	0.00	30.34	0.00
23	BFS5	12/16/91	0	24	PM_{10}	15.00	0.14	0.00	45.63	0.00	0.00	0.00	0.00	0.00	20.71	0.00

Table 4.2. Basic CMB Model Results by Major Source Category (Percent)

CMB NO.	SITE	DATE	START TIME	DUR.	PM Size	SOURCE CATEGORY (Percent)										
						Road Dust (1)	Motor Vehicles (2)	Other Trans. (3)	Wood Comb. (4)	Other Comb. (5)	Boilers (6)	Inciner. (7)	Indust. (8)	Mineral Dust and Proc. (9)	Sec. (10)	Other (11)
1	BFS5	12/22/99	0	24	PM_{10}	55.6	6.5	0.0	31.2	0.0	0.0	0.0	0.0	0.0	6.8	0.0
2	BFS5	12/24/99	0	24	PM_{10}	38.9	0.0	0.0	29.0	0.0	0.0	0.0	0.0	0.0	32.1	0.0
3	BFS5	12/25/99	0	24	PM_{10}	6.1	0.0	0.0	43.6	0.0	0.0	0.0	0.0	0.0	50.3	0.0
4	BFS5	12/22/99	0	5	$PM_{2.5}$	18.8	22.6	0.0	44.8	0.0	0.0	0.0	0.0	0.0	13.8	0.0
5	BFS5	12/22/99	5	5	$PM_{2.5}$	24.6	25.0	0.0	33.0	0.0	0.0	0.0	0.0	0.0	17.3	0.0
6	BFS5	12/22/99	10	5	$PM_{2.5}$	36.4	9.8	0.0	27.1	0.0	0.0	0.0	0.0	0.0	26.7	0.0
7	BFS5	12/22/99	14	4	$PM_{2.5}$	34.6	11.9	0.0	38.6	0.0	0.0	0.0	0.0	0.0	14.8	0.0
8	BFS5	12/22/99	19	5	$PM_{2.5}$	19.7	0.0	0.0	68.1	0.0	0.0	0.0	0.0	0.0	12.1	0.0
9	BFS5	12/24/99	0	5	$PM_{2.5}$	3.6	0.0	0.0	62.0	0.0	0.0	0.0	0.0	0.0	34.4	0.0
10	BFS5	12/24/99	5	5	$PM_{2.5}$	0.0	0.0	0.0	69.2	0.0	0.0	0.0	0.0	0.0	30.8	0.0
11	BFS5	12/24/99	10	5	$PM_{2.5}$	15.1	7.6	0.0	37.9	0.0	0.0	0.0	0.0	0.0	39.4	0.0
12	BFS5	12/24/99	14	4	$PM_{2.5}$	5.7	0.0	0.0	32.0	0.0	0.0	0.0	0.0	0.0	62.2	0.0
13	BFS5	12/24/99	19	5	$PM_{2.5}$	0.0	0.0	0.0	44.3	0.0	0.0	0.0	0.0	0.0	55.7	0.0
14	BFS5	12/25/99	0	10	$PM_{2.5}$	0.0	0.0	0.0	46.7	0.0	0.0	0.0	0.0	0.0	53.3	0.0
15	BFS5	12/25/99	10	9	$PM_{2.5}$	0.0	0.0	0.0	43.8	0.0	0.0	0.0	0.0	0.0	56.2	0.0
16	BFS5	12/25/99	19	5	$PM_{2.5}$	0.0	0.0	0.0	47.1	0.0	0.0	0.0	0.0	0.0	52.9	0.0
17	BFS5	1/4/91	0	24	PM_{10}	8.5	5.0	0.0	31.0	0.0	0.0	0.0	0.0	0.0	55.5	0.0
18	**BMVS**	1/4/91	0	24	PM_{10}	4.4	6.1	0.0	25.9	0.0	0.0	0.0	0.0	0.0	63.6	0.0
19	BFS5	1/7/91	0	24	PM_{10}	4.5	0.1	0.0	31.1	0.0	0.0	0.0	0.0	0.0	64.3	0.0
20	**BMVS**	1/7/91	0	24	PM_{10}	3.0	0.1	0.0	27.0	0.0	0.0	0.0	0.0	0.0	69.9	0.0
21	BFS5	2/1/91	0	24	PM_{10}	67.3	6.9	0.0	15.2	0.0	0.0	0.0	0.0	0.0	10.6	0.0
22	BFS5	12/4/91	0	24	PM_{10}	23.5	0.2	0.0	43.1	0.0	0.0	0.0	0.0	0.0	33.2	0.0
23	BFS5	12/16/91	0	24	PM_{10}	18.4	0.2	0.0	56.0	0.0	0.0	0.0	0.0	0.0	25.4	0.0

Table 4.3. CMB-EIS Model Results for Boise, ID (μg/m³)

Categ.	Date	12/22 1999	12/24 1999	12/25 1999	12/22 1999	12/22 1999	12/22 1999	12/22 1999	12/22 1999	12/24 1999	12/24 1999	12/24 1999	12/24 1999	12/24 1999	12/25 1999	12/25 1999	12/25 1999	1/4 1991	1/4 1991	1/7 1991	1/7 1991	2/1 1991	12/4 1991	12/16 1991
Categ.	Duration (hrs)	24	24	24	5	5	5	5	5	5	5	5	5	5	10	9	5	24	24	24	24	24	24	24
	Time (hr of day)	0	0	0	0	5	10	14	19	0	5	10	14	19	0	10	19	0	0	0	0	0	0	0
	PM Type	PM_{10}	PM_{10}	PM_{10}	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}
	Total PM	70.00	69.00	37.00	24.31	28.48	26.54	16.97	27.70	40.46	48.62	38.51	40.48	44.75	35.27	38.14	35.49	149.00	152.00	173.00	164.00	126.00	107.00	98.00
Road Dust	Primary PM	38.66	23.82	2.15	4.56	7.06	11.90	6.53	6.07	1.47	0.00	6.22	2.50	0.00	0.00	0.00	0.00	11.91	5.88	7.96	4.44	70.00	21.51	15.00
Gas Vehic.	Primary PM	1.64	1.14	0.57	1.26	2.26	1.20	1.65	1.74	1.06	1.67	1.51	0.74	0.81	0.58	0.57	0.53	4.43	4.43	3.66	3.66	4.13	2.30	3.28
	Am. Sulfate	0.53	2.72	1.52	0.33	0.57	0.45	0.22	0.23	1.26	1.59	1.33	3.55	3.30	1.51	1.67	1.41	13.03	14.65	17.75	16.00	1.82	6.04	4.50
	Am. Nitrate	1.63	6.55	6.59	1.19	1.71	3.50	1.05	1.45	5.33	5.06	6.26	9.20	7.59	6.07	7.37	6.66	23.11	24.75	34.99	32.31	3.28	8.07	5.15
	TOTAL GAS	3.80	10.41	8.69	2.79	4.54	5.15	2.92	3.43	7.64	8.31	9.10	13.49	11.70	8.16	9.62	8.60	40.56	43.83	56.39	51.96	9.23	16.41	12.93
Diesel Vehic.	Primary PM	3.70	2.58	1.28	2.85	5.11	2.71	3.73	3.93	2.39	3.76	3.42	1.68	1.83	1.32	1.29	1.20	10.00	10.00	8.27	8.27	9.33	5.20	7.41
	Am. Sulfate	0.16	0.80	0.45	0.10	0.17	0.13	0.06	0.07	0.37	0.47	0.39	1.04	0.97	0.44	0.49	0.41	3.82	4.29	5.20	4.69	0.53	1.77	1.32
	Am. Nitrate	1.48	5.76	5.61	1.09	1.56	3.18	0.96	1.32	4.69	4.45	5.50	8.09	6.68	5.16	6.27	5.66	20.31	21.75	30.75	28.39	2.88	7.09	4.53
	TOTAL DIESEL	5.34	9.14	7.34	4.03	6.84	6.02	4.75	5.32	7.45	8.68	9.31	10.81	9.48	6.92	8.05	7.28	34.12	36.04	44.21	41.34	12.75	14.06	13.25
Resid. Wood Comb.	Primary PM	19.38	19.81	14.70	11.20	8.26	1.83	2.07	11.14	19.49	26.39	10.07	7.69	17.29	16.20	15.90	15.54	42.23	44.14	37.01	40.85	29.82	45.04	48.78
	Am. Sulfate	0.08	0.40	0.67	0.05	0.09	0.07	0.03	0.04	0.18	0.23	0.20	0.52	0.48	0.67	0.74	0.62	3.24	3.64	4.41	3.97	0.45	1.50	1.12
	Am. Nitrate	0.03	0.12	0.35	0.02	0.03	0.07	0.02	0.03	0.10	0.09	0.12	0.17	0.14	0.32	0.39	0.36	0.72	0.77	1.09	1.01	0.10	0.25	0.16
	TOTAL RWC	19.49	20.33	15.72	11.28	8.39	1.97	2.13	11.21	19.77	26.72	10.38	8.39	17.91	17.19	17.04	16.52	46.18	48.55	42.51	45.83	30.37	46.79	50.06
Other Comb.	Primary PM	1.92	1.96	0.46	1.11	0.82	0.18	0.21	1.10	1.93	2.61	1.00	0.76	1.71	0.51	0.50	0.49	2.44	2.55	2.14	2.36	1.72	2.60	2.82
	Am. Sulfate	0.30	1.47	0.82	0.19	0.32	0.25	0.12	0.13	0.68	0.86	0.72	1.92	1.78	0.82	0.91	0.76	7.14	8.03	9.72	8.77	1.00	3.31	2.46
	Am. Nitrate	0.50	1.86	1.81	0.36	0.52	1.07	0.32	0.44	1.52	1.44	1.78	2.62	2.16	1.67	2.03	1.83	6.64	7.12	10.06	9.29	0.94	2.32	1.48
	TOTAL O. COMB.	2.71	5.30	3.10	1.66	1.66	1.50	0.65	1.68	4.12	4.91	3.50	5.30	5.65	3.00	3.43	3.08	16.22	17.69	21.92	20.41	3.66	8.23	6.76

Table 4.4. CMB-EIS Model Results for Boise, ID (Percent)

Categ.	Date	12/22 1999	12/24 1999	12/25 1999	12/22 1999	12/22 1999	12/22 1999	12/22 1999	12/22 1999	12/24 1999	12/24 1999	12/24 1999	12/24 1999	12/24 1999	12/25 1999	12/25 1999	12/25 1999	1/4 1991	1/4 1991	1/7 1991	1/7 1991	2/1 1991	12/4 1991	12/16 1991
	Duration (hrs)	24	24	24	5	5	5	5	5	5	5	5	5	5	10	9	5	24	24	24	24	24	24	24
	Time (hr of day)	0	0	0	0	5	10	14	19	0	5	10	14	19	0	10	19	0	0	0	0	0	0	0
	PM Type	PM_{10}	PM_{10}	PM_{10}	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}
Road Dust	Primary PM	55.22	34.53	5.82	18.75	24.78	44.84	38.46	21.90	3.63	0.00	16.16	6.18	0.00	0.00	0.00	0.00	8.00	3.87	4.60	2.71	55.56	20.10	15.31
Gas Vehic.	Primary PM	2.34	1.66	1.54	5.18	7.94	4.52	9.71	6.27	2.62	3.42	3.93	1.84	1.81	1.65	1.50	1.50	2.97	2.91	2.12	2.23	3.28	2.15	3.35
	Am. Sulfate	0.76	3.94	4.12	1.37	2.00	1.69	1.28	0.85	3.10	3.27	3.46	8.76	7.37	4.28	4.39	3.98	8.75	9.64	10.26	9.76	1.44	5.64	4.59
	Am. Nitrate	2.33	9.49	17.82	4.91	6.01	13.19	6.21	5.25	13.17	10.40	16.24	22.73	16.97	17.21	19.33	18.76	15.51	16.28	20.22	19.70	2.60	7.54	5.26
	TOTAL GAS	5.43	15.09	23.48	11.46	15.95	19.39	17.20	12.37	18.89	17.10	23.63	33.32	26.15	23.14	25.22	24.24	27.22	28.84	32.60	31.69	7.32	15.33	13.19
Diesel Vehic.	Primary PM	5.29	3.75	3.47	11.70	17.95	10.21	21.95	14.18	5.92	7.74	8.88	4.15	4.10	3.74	3.38	3.39	6.71	6.58	4.78	5.04	7.41	4.86	7.56
	Am. Sulfate	0.22	1.15	1.21	0.40	0.59	0.49	0.37	0.25	0.91	0.96	1.01	2.56	2.16	1.25	1.28	1.16	2.56	2.82	3.00	2.86	0.42	1.65	1.34
	Am. Nitrate	2.12	8.35	15.15	4.47	5.46	11.99	5.65	4.78	11.58	9.15	14.28	19.99	14.92	14.63	16.44	15.96	13.63	14.31	17.77	17.31	2.28	6.63	4.62
	TOTAL DIESEL	7.63	13.25	19.83	16.57	24.00	22.70	27.98	19.21	18.41	17.85	24.18	26.70	21.18	19.62	21.11	20.51	22.90	23.71	25.56	25.21	10.12	13.14	13.52
Resid. Wood Comb.	Primary PM	27.68	28.70	39.72	46.08	29.01	6.91	12.22	40.22	48.17	54.28	26.14	19.00	38.64	45.94	41.70	43.79	28.34	29.04	21.40	24.91	23.66	42.10	49.78
	Am. Sulfate	0.12	0.58	1.82	0.21	0.30	0.26	0.19	0.13	0.46	0.48	0.51	1.28	1.08	1.89	1.94	1.76	2.17	2.39	2.55	2.42	0.36	1.40	1.14
	Am. Nitrate	0.05	0.18	0.95	0.10	0.12	0.26	0.12	0.10	0.24	0.19	0.30	0.42	0.32	0.92	1.03	1.00	0.48	0.51	0.63	0.61	0.08	0.23	0.16
	TOTAL RWC	27.84	29.46	42.49	46.39	29.44	7.43	12.54	40.46	48.87	54.95	26.95	20.71	40.03	48.75	44.67	46.55	30.99	31.94	24.57	27.95	24.10	43.73	51.08
Other Comb.	Primary PM	2.74	2.84	1.25	4.56	2.87	0.68	1.21	3.98	4.77	5.37	2.59	1.88	3.82	1.45	1.31	1.38	1.64	1.68	1.23	1.44	1.37	2.43	2.87
	Am. Sulfate	0.43	2.13	2.23	0.77	1.12	0.95	0.72	0.48	1.68	1.77	1.87	4.74	3.99	2.31	2.37	2.15	4.79	5.28	5.62	5.35	0.79	3.09	2.51
	Am. Nitrate	0.71	2.70	4.90	1.50	1.83	4.02	1.89	1.60	3.75	2.96	4.62	6.46	4.83	4.73	5.32	5.16	4.46	4.68	5.82	5.66	0.75	2.17	1.51
	TOTAL O. COMB.	3.88	7.67	8.38	6.83	5.83	5.65	3.82	6.06	10.19	10.10	9.08	13.08	12.64	8.49	9.00	8.69	10.89	11.64	12.67	12.45	2.90	7.69	6.90

Table 4.5. Summary of CMB-EIS Model Results by Major Source Category (µg/m³)

CMB NO.	SITE	DATE	START TIME	DUR.	PM TYPE	SOURCE CATEGORY (µg/m³)						
						MOBILE			COMBUSTION		NON-ROAD	IND. POINT
						Road Dust	Gas	Diesel	Wood Comb.	Other Comb.		
1	BFS5	12/22/99	0	24	PM_{10}	38.66 +/- 2.64	3.8 +/- 1.14	5.34 +/- 1.6	19.49 +/- 5.85	2.71 +/- 0.81	a	a
2	BFS5	12/24/99	0	24	PM_{10}	23.82 +/- 2.15	10.41 +/- 3.12	9.14 +/- 2.74	20.33 +/- 6.1	5.3 +/- 1.59	a	a
3	BFS5	12/25/99	0	24	PM_{10}	2.15 +/- 0.24	8.69 +/- 2.61	7.34 +/- 2.2	15.72 +/- 4.72	3.1 +/- 0.93	a	a
4	BFS5	12/22/99	0	5	$PM_{2.5}$	4.56 +/- 0.46	2.79 +/- 0.84	4.03 +/- 1.21	11.28 +/- 3.38	1.66 +/- 0.5	a	a
5	BFS5	12/22/99	5	5	$PM_{2.5}$	7.06 +/- 0.62	4.54 +/- 1.36	6.84 +/- 2.05	8.39 +/- 2.52	1.66 +/- 0.5	a	a
6	BFS5	12/22/99	10	5	$PM_{2.5}$	11.9 +/- 0.94	5.15 +/- 1.54	6.02 +/- 1.81	1.97 +/- 0.59	1.5 +/- 0.45	a	a
7	BFS5	12/22/99	14	4	$PM_{2.5}$	6.53 +/- 0.69	2.92 +/- 0.88	4.75 +/- 1.42	2.13 +/- 0.64	0.65 +/- 0.19	a	a
8	BFS5	12/22/99	19	5	$PM_{2.5}$	6.07 +/- 1.45	3.43 +/- 1.03	5.32 +/- 1.6	11.21 +/- 3.36	1.68 +/- 0.5	a	a
9	BFS5	12/24/99	0	5	$PM_{2.5}$	1.47 +/- 0.83	7.64 +/- 2.29	7.45 +/- 2.23	19.77 +/- 5.93	4.12 +/- 1.24	a	a
10	BFS5	12/24/99	5	5	$PM_{2.5}$	0 +/- 1	8.31 +/- 2.49	8.68 +/- 2.6	26.72 +/- 8.01	4.91 +/- 1.47	a	a
11	BFS5	12/24/99	10	5	$PM_{2.5}$	6.22 +/- 0.62	9.1 +/- 2.73	9.31 +/- 2.79	10.38 +/- 3.11	3.5 +/- 1.05	a	a
12	BFS5	12/24/99	14	4	$PM_{2.5}$	2.5 +/- 0.92	13.49 +/- 4.05	10.81 +/- 3.24	8.39 +/- 2.52	5.3 +/- 1.59	a	a
13	BFS5	12/24/99	19	5	$PM_{2.5}$	0 +/- 1	11.7 +/- 3.51	9.48 +/- 2.84	17.91 +/- 5.37	5.65 +/- 1.7	a	a
14	BFS5	12/25/99	0	10	$PM_{2.5}$	0 +/- 1	8.16 +/- 2.45	6.92 +/- 2.08	17.19 +/- 5.16	3 +/- 0.9	a	a
15	BFS5	12/25/99	10	9	$PM_{2.5}$	0 +/- 1	9.62 +/- 2.89	8.05 +/- 2.42	17.04 +/- 5.11	3.43 +/- 1.03	a	a
16	BFS5	12/25/99	19	5	$PM_{2.5}$	0 +/- 1	8.6 +/- 2.58	7.28 +/- 2.18	16.52 +/- 4.96	3.08 +/- 0.93	a	a
17	BFS5	1/4/91	0	24	PM_{10}	11.91 +/- 1.67	40.56 +/- 12.17	34.12 +/- 10.24	46.18 +/- 13.85	16.22 +/- 4.87	a	a
18	BMVS	1/4/91	0	24	PM_{10}	5.88 +/- 1.06	43.83 +/- 13.15	36.04 +/- 10.81	48.55 +/- 14.57	17.69 +/- 5.31	a	a
19	BFS5	1/7/91	0	24	PM_{10}	7.96 +/- 1.08	56.39 +/- 16.92	44.21 +/- 13.26	42.51 +/- 12.75	21.92 +/- 6.58	a	a
20	BMVS	1/7/91	0	24	PM_{10}	4.44 +/- 0.68	51.96 +/- 15.59	41.34 +/- 12.4	45.83 +/- 13.75	20.41 +/- 6.12	a	a
21	BFS5	2/1/91	0	24	PM_{10}	70 +/- 9.46	9.23 +/- 2.77	12.75 +/- 3.82	30.37 +/- 9.11	3.66 +/- 1.1	a	a
22	BFS5	12/4/91	0	24	PM_{10}	21.51 +/- 2.73	16.41 +/- 4.92	14.06 +/- 4.22	46.79 +/- 14.04	8.23 +/- 2.47	a	a
23	BFS5	12/16/91	0	24	PM_{10}	15 +/- 2.67	12.93 +/- 3.88	13.25 +/- 3.98	50.06 +/- 15.02	6.76 +/- 2.03	a	a

a) Below quantification limit of about 0.5 µg/m³

Table 4.6. Summary of CMB-EIS Model Results by Major Source Category (Percent)

CMB NO.	SITE	DATE	START TIME	DUR.	PM TYPE	SOURCE CATEGORY (percent)						
						MOBILE			COMBUSTION		NON-ROAD	IND. POINT
						Road Dust	Gas	Diesel	Wood Comb.	Other Comb.		
1	BFS5	12/22/99	0	24	PM_{10}	55.2 +/- 3.8	5.4 +/- 1.6	7.6 +/- 2.3	27.8 +/- 8.4	3.9 +/- 1.2	a	a
2	BFS5	12/24/99	0	24	PM_{10}	34.5 +/- 3.1	15.1 +/- 4.5	13.2 +/- 4	29.5 +/- 8.8	7.7 +/- 2.3	a	a
3	BFS5	12/25/99	0	24	PM_{10}	5.8 +/- 0.6	23.5 +/- 7	19.8 +/- 5.9	42.5 +/- 12.7	8.4 +/- 2.5	a	a
4	BFS5	12/22/99	0	5	$PM_{2.5}$	18.7 +/- 1.9	11.5 +/- 3.4	16.6 +/- 5	46.4 +/- 13.9	6.8 +/- 2	a	a
5	BFS5	12/22/99	5	5	$PM_{2.5}$	24.8 +/- 2.2	15.9 +/- 4.8	24 +/- 7.2	29.4 +/- 8.8	5.8 +/- 1.7	a	a
6	BFS5	12/22/99	10	5	$PM_{2.5}$	44.8 +/- 3.5	19.4 +/- 5.8	22.7 +/- 6.8	7.4 +/- 2.2	5.7 +/- 1.7	a	a
7	BFS5	12/22/99	14	4	$PM_{2.5}$	38.5 +/- 4.1	17.2 +/- 5.2	28 +/- 8.4	12.5 +/- 3.8	3.8 +/- 1.1	a	a
8	BFS5	12/22/99	19	5	$PM_{2.5}$	21.9 +/- 5.2	12.4 +/- 3.7	19.2 +/- 5.8	40.5 +/- 12.1	6.1 +/- 1.8	a	a
9	BFS5	12/24/99	0	5	$PM_{2.5}$	3.6 +/- 2	18.9 +/- 5.7	18.4 +/- 5.5	48.9 +/- 14.7	10.2 +/- 3.1	a	a
10	BFS5	12/24/99	5	5	$PM_{2.5}$	0 +/- 2.1	17.1 +/- 5.1	17.8 +/- 5.4	54.9 +/- 16.5	10.1 +/- 3	a	a
11	BFS5	12/24/99	10	5	$PM_{2.5}$	16.2 +/- 1.6	23.6 +/- 7.1	24.2 +/- 7.3	27 +/- 8.1	9.1 +/- 2.7	a	a
12	BFS5	12/24/99	14	4	$PM_{2.5}$	6.2 +/- 2.3	33.3 +/- 10	26.7 +/- 8	20.7 +/- 6.2	13.1 +/- 3.9	a	a
13	BFS5	12/24/99	19	5	$PM_{2.5}$	0 +/- 2.2	26.2 +/- 7.8	21.2 +/- 6.4	40 +/- 12	12.6 +/- 3.8	a	a
14	BFS5	12/25/99	0	10	$PM_{2.5}$	0 +/- 2.8	23.1 +/- 6.9	19.6 +/- 5.9	48.7 +/- 14.6	8.5 +/- 2.5	a	a
15	BFS5	12/25/99	10	9	$PM_{2.5}$	0 +/- 2.6	25.2 +/- 7.6	21.1 +/- 6.3	44.7 +/- 13.4	9 +/- 2.7	a	a
16	BFS5	12/25/99	19	5	$PM_{2.5}$	0 +/- 2.8	24.2 +/- 7.3	20.5 +/- 6.2	46.6 +/- 14	8.7 +/- 2.6	a	a
17	BFS5	1/4/91	0	24	PM_{10}	8 +/- 1.1	27.2 +/- 8.2	22.9 +/- 6.9	31 +/- 9.3	10.9 +/- 3.3	a	a
18	BMVS	1/4/91	0	24	PM_{10}	3.9 +/- 0.7	28.8 +/- 8.7	23.7 +/- 7.1	31.9 +/- 9.6	11.6 +/- 3.5	a	a
19	BFS5	1/7/91	0	24	PM_{10}	4.6 +/- 0.6	32.6 +/- 9.8	25.6 +/- 7.7	24.6 +/- 7.4	12.7 +/- 3.8	a	a
20	BMVS	1/7/91	0	24	PM_{10}	2.7 +/- 0.4	31.7 +/- 9.5	25.2 +/- 7.6	27.9 +/- 8.4	12.4 +/- 3.7	a	a
21	BFS5	2/1/91	0	24	PM_{10}	55.6 +/- 7.5	7.3 +/- 2.2	10.1 +/- 3	24.1 +/- 7.2	2.9 +/- 0.9	a	a
22	BFS5	12/4/91	0	24	PM_{10}	20.1 +/- 2.5	15.3 +/- 4.6	13.1 +/- 3.9	43.7 +/- 13.1	7.7 +/- 2.3	a	a
23	BFS5	12/16/91	0	24	PM_{10}	15.3 +/- 2.7	13.2 +/- 4	13.5 +/- 4.1	51.1 +/- 15.3	6.9 +/- 2.1	a	a

a) Below quantification limit of about 1%

Table 4.7 EIP-CMB Model Source Contribution Estimate (Percent Species)

Date/Species	Gas Vehicles	Diesel Vehicles	Stat. Combustion
12/22/99			
SO_X-S	56.4	19.3	24.3
NO_X-N	44.9	46.4	8.7
CO	93.5	1.2	5.4
PRIM. PM_{10}	6.9	17.7	75.4
12/24/99			
SO_X-S	50.0	18.4	31.7
NO_X-N	41.7	46.4	11.9
CO	91.1	1.2	7.7
PRIM. PM_{10}	5.1	14.0	80.9
12/25/99			
SO_X-S	50.4	2.9	46.7
NO_X-N	62.9	10.9	26.2
CO	88.9	0.2	10.9
PRIM. PM_{10}	4.0	1.7	94.2

The results from the EIP-CMB model are compared to the CMB-EIS model results in Table 4.8. The results generally agree quite well except for the diesel vehicle and ammonium nitrate contributions on the 25^{th} of December. On this day, the CMB-EIS result for the diesel vehicle impact is over three fold higher than EIP-CMB model results for all three source components, primary PM_{10}, secondary sulfate and secondary nitrate. Based on our general understanding of events on the 25^{th}, the ratio of diesel vehicle emissions to gasoline vehicle emissions should be less on the 25^{th} than on the two preceding days. However, the CMB-EIS model results indicate that their impacts are essentially the same on all three days. The EIP-CMB model, on the other hand, indicates that the diesel to gasoline vehicle SCE ratio is substantially less on the 25^{th} than the two preceding days as would be expected from the expected low diesel traffic on Christmas day.

This illustrates one of the key differences between these two models. The CMB-EIS model is limited by the accuracy of the emission inventory on the day modeled. As such, the emission inventory fixes the relative source category contributions. Since the diesel to gasoline vehicle emissions ratios didn't change significantly between the first two days modeled and the 25^{th}, the source impact ratios didn't change. The EIP-CMB model, on the other hand, fixes the relative species concentrations within a source category, and allows the relative source category contributions to vary independently to fit the ambient data. Thus, if the relative species concentrations are the same from one day to the next, the EIP-CMB model should better reflect the changing relative impacts of the various source categories. As such, the EIP-CMB results on the 25^{th} are expected to be a better reflection of the

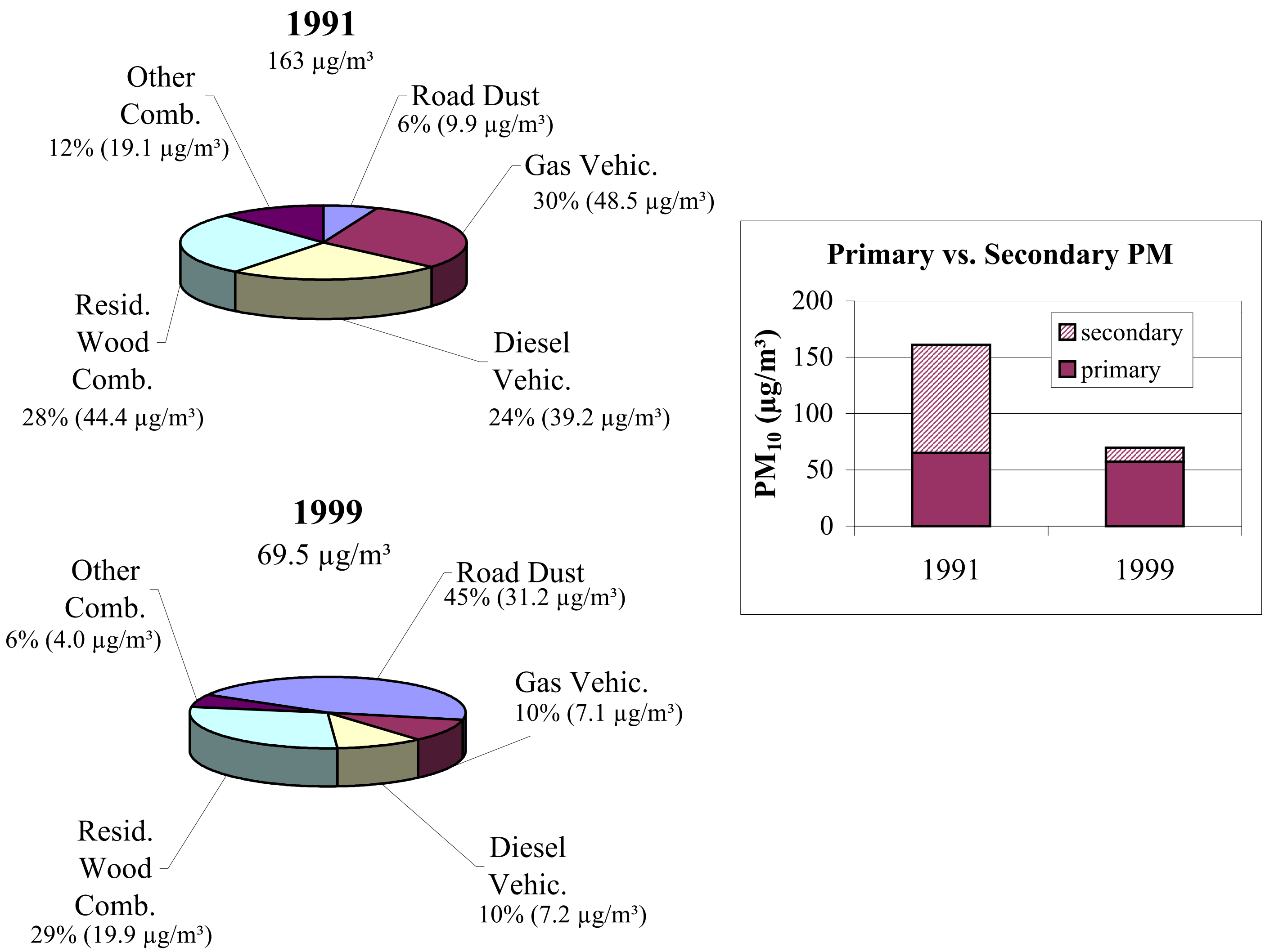
Table 4.8 Comparison of EIP-CMB and CMB-EIS Model Results

Source Category	Species	SCEs (µg/m³)						SCEs (% PM_{10})					
		12/22/99		12/24/99		12/25/99		12/22/99		12/24/99		12/25/99	
		CMB-EIS	EIP-CMB	CMB-EIS	EIP-CMB	CMB-EIS	EIP-CMB	CMB-EIS	EIP-CMB	CMB-EIS	EIP-CMB	CMB-EIS	EIP-CMB
Road Dust	Primary PM	38.66	38.66	23.82	23.82	2.15	2.15	55.22	55.22	34.53	34.53	5.82	5.82
Gasoline Vehicles	Primary PM	1.64	1.84	1.14	1.29	0.57	0.69	2.34	2.63	1.66	1.87	1.54	1.85
	Am. Sulfate	0.53	0.60	2.72	2.69	1.52	1.75	0.76	0.86	3.94	3.90	4.12	4.73
	Am. Nitrate	1.63	1.64	6.55	5.96	6.59	9.04	2.33	2.34	9.49	8.64	17.82	24.44
	Total	3.80	4.08	10.41	9.95	8.69	11.48	5.43	5.83	15.09	14.42	23.48	31.02
Diesel Vehicles	Primary PM	3.70	4.72	2.58	3.57	1.28	0.29	5.29	6.75	3.75	5.17	3.47	0.80
	Am. Sulfate	0.16	0.21	0.80	0.99	0.45	0.10	0.22	0.29	1.15	1.44	1.21	0.27
	Am. Nitrate	1.48	1.69	5.76	6.63	5.61	1.56	2.12	2.41	8.35	9.61	15.15	4.23
	Total	5.34	6.62	9.14	11.19	7.34	1.96	7.63	9.45	13.25	16.22	19.83	5.30
Resid. Wood Comb.	Primary PM	19.38	18.27	19.81	18.78	14.70	15.54	27.68	26.09	28.70	27.22	39.72	42.00
	Am. Sulfate	0.08	0.06	0.40	0.36	0.67	0.73	0.12	0.08	0.58	0.53	1.82	1.97
	Am. Nitrate	0.03	0.02	0.12	0.10	0.35	0.61	0.05	0.03	0.18	0.15	0.95	1.65
	Total	19.49	18.34	20.33	19.25	15.72	16.88	27.84	26.20	29.46	27.89	42.49	45.62
Other Comb.	Primary PM	1.92	1.81	1.96	1.86	0.46	0.49	2.74	2.58	2.84	2.69	1.25	1.32
	Am. Sulfate	0.30	0.20	1.47	1.34	0.82	0.89	0.43	0.29	2.13	1.94	2.23	2.41
	Am. Nitrate	0.50	0.30	1.86	1.59	1.81	3.15	0.71	0.43	2.70	2.31	4.90	8.51
	Total	2.71	2.31	5.30	4.79	3.10	4.53	3.88	3.30	7.67	6.95	8.38	12.24
TOTAL		70.00	70.00	69.00	69.00	37.00	37.00	100.00	100.00	100.00	100.00	100.00	100.00

actual source impacts on Christmas. The good agreement on the other two days suggests that the CMB-EIS model results should be reasonably good for the other, more normal periods modeled. However, the biggest limitation will be applicability of the 1999 emission inventory to the 1991 data base as was used with the CMB-EIS model.

Source contribution estimates for the two highest PM_{10} days in 1991 and two highest days in 1999 are compared in Figure 4.1. Impacts from gasoline vehicles, diesel vehicles and wood combustion were about equal in 1991 and together accounted for 82% of the PM_{10}. However, road dust, which accounted for only 6% of the PM_{10} in 1991, was responsible for 45 % of the PM_{10} in 1999, and the other three source categories contributed only 49% of the PM_{10}. Although the average primary PM_{10} concentrations were similar, the secondary component in 1991 was over eight fold higher in 1991 than in 1999 as illustrated in the bar chart in Figure 4.1, and accounted for almost 60% of the 1991 PM_{10} concentration. The average mobile source category impact in 1991 was 60 % of the PM_{10} (97.6 µg/m3) and 65 % (45.5 µg/m3) in 1999.

Figure 4.1 Comparison of CMB-EIS SCEs For Two Highest PM_{10} Days in 1999 Study Period With Two Highest PM_{10} Episode Days in 1991



5.0 MODEL RECONCILIATION

5.1 Overview

The basic CMB SCEs reported in Appendix B and summarized in the preceding section represent the optimum model solutions for each receptor sample, and are the most probable SCEs. However, the EPA recommends that these results be verified by comparing them to other available information to develop an internally consistent database, which supports the final impact estimates. This concept of model verification is like building a bridge of evidence. The objective is to build a strong bridge of evidence not only connecting the sources to their impact, but also quantifying these impacts. There are different types of information that can relate the source to an impact at an ambient monitor. Some of the information is qualitative while information from models such as the CMB, CMB-EIS, and EIP-CMB models are quantitative estimates. To the extent the available information is internally consistent, a higher level of confidence can be placed on the results. In some cases of inconsistency, the source of the inconsistency can be found and rectified.

The objective of this section is to review the available information on Boise PM_{10}, and use this information to evaluate the validity of the CMB SCEs reported in the preceding section and used to reconcile the dispersion model.

5.2 Conceptual Model

Treasure Valley is a broad valley located in the in the southwest portion of Idaho sloping downward from the southeast to northwest. The Boise metropolitan area is located on the northern edge of this valley as shown in Figure 5.1. The Boise fire station No. 5 monitoring site, which has historically recorded winter PM_{10} concentrations greater than the standard level is located near the center of the Boise metropolitan area.

Meteorology during winter air stagnation episodes is a major contributor to the high PM_{10} levels measured at this monitor. The meteorological factors responsible for winter pollution episodes are well characterized (IDEQ, 1998). These air stagnation periods generally begin with the passage of a cold-air low-pressure system with a snowfall of a few inches on the valley floor. After such a storm leaves the Treasure Valley area, a surface high-pressure system begins to build into the area. The first clear night after frontal passage causes a nocturnal cooling and surface based inversion, which inhibits ventilation of near ground level emitted pollutants. As the surface high pressure intensifies, visibility decreases rapidly, fogs can form further exacerbating conditions, and PM_{10} values rise. Extended stagnation conditions are established if surface high pressure is reinforced by a strong high-pressure ridge aloft. This can create additional stable subsiding layers of inversion above ground. If the upper level high-pressure ridge covers the western states, the stagnation conditions will usually persist from seven to ten days. Wind speeds during a stagnation episode are light and variable, and are largely controlled by local topographic circulation patterns (IDEQ, 1998). The winds throughout the valley are variable and dependent on the time of day as illustrated schematically in Figures 4.1 to 4.3. This daily meteorological pattern is fairly constant

Figure 5.1 Relief Map of the Treasure Valley Airshed.

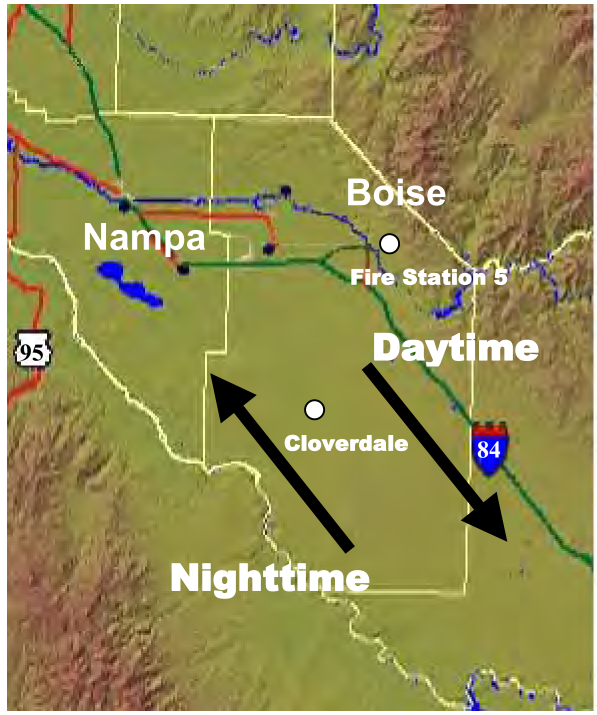
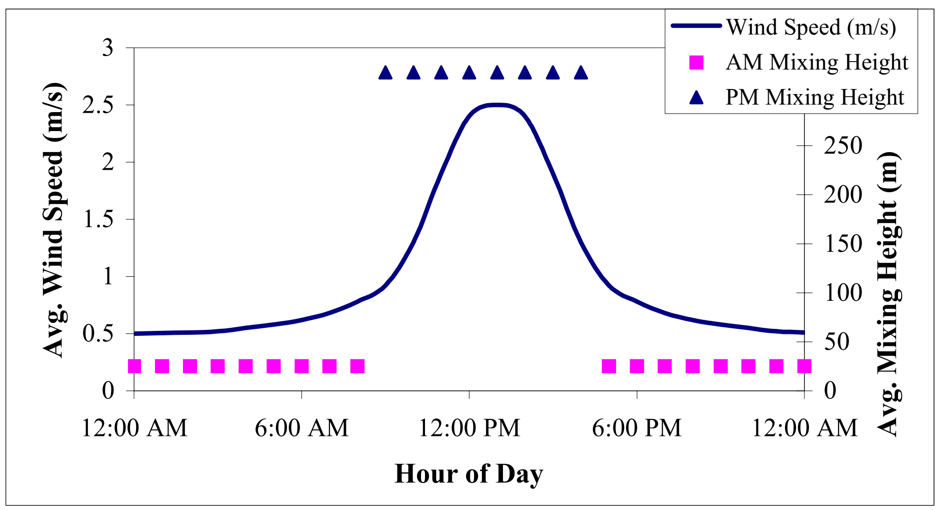


Figure 5.2 Typical Meteorological Patterns During a Boise PM_{10} Episode



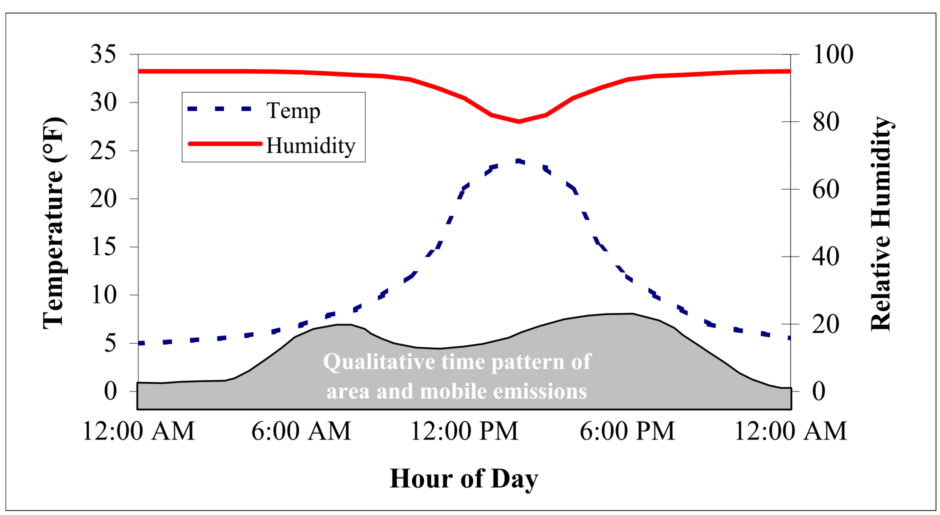
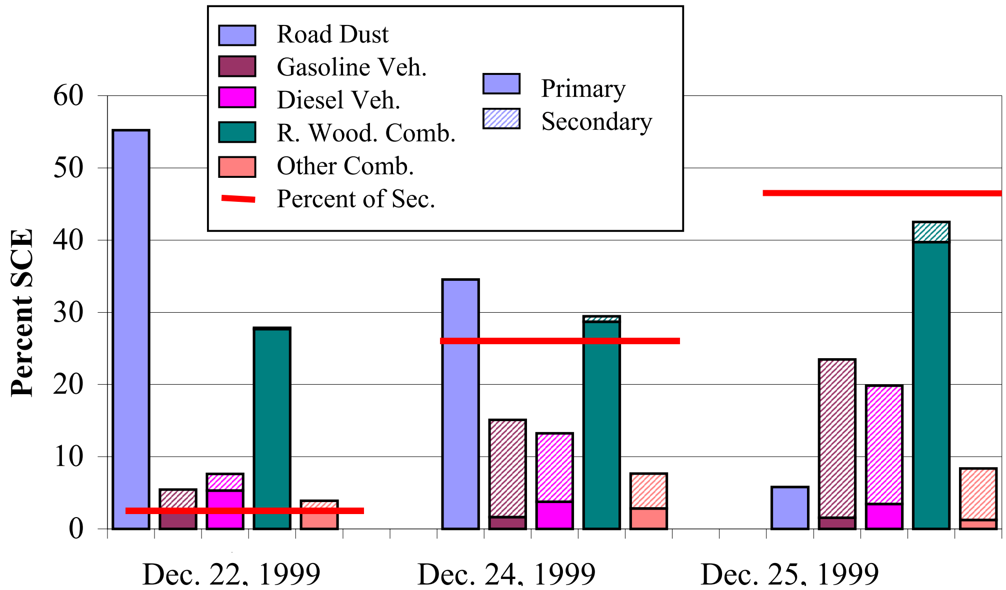


Figure 5.3 CMB-EIS source Contribution Estimates (Percent) for the Three Study Days



from one day to the next during a pollution episode. In the early morning, winds are flowing down the mountain slopes, canyons and the Treasure Valley towards lower elevations in the northwest. During midmorning, the mountain slopes and canyon walls absorb solar radiation, heat up and cause a reversal of airflow from down-slope/valley to up-slope/valley. As dusk approaches, the mountain slopes begin to cool and the airflow once again reverses to a down-slope/valley flow. During this transition period, areas in the valley can experience near calm conditions and lowering inversion heights, which can coincide with evening rush hour and peak vehicle emissions.

Measured meteorological conditions during the high PM_{10} days considered in this study are consistent with the above meteorological model. This conceptual model shows that for two thirds of the time during a typical high PM_{10} day, emissions from the major industrial sources located north of Nampa were flowing to the northwest away from the Boise monitor. During mid-day, the temperature, wind speeds, and inversion height increase, while the humidity decreases. Under these daytime conditions, the airflow is moving the industrial emissions up valley to the southeast towards the Cloverdale monitoring site. This mid-day meteorology contributes to an increase in dispersion and dilution of emissions, while a decreasing humidity reduces the SO_2 to sulfate conversion rate to a few percent per hour (Seinfeld, 1998, Gillani, 1983, Pandis, 1992).

The chemical composition of PM_{10} during these winter PM_{10} stagnation episodes is similar. Although PM_{10} is a complex mixture of hundreds of chemical and mineral species; three ions (nitrate, sulfate, and ammonium), two classes of carbon species (organic and elemental carbon) and associated water typically account for about 90% of the PM_{10} mass during these winter PM_{10} episodes. This is in part a reflection of the dominant contribution of common area and mobile sources present in the Boise metropolitan airshed, and the common diurnal pattern of emissions and meteorology during a PM_{10} episode.

5.3 CMB Model Assumptions

There are a number of assumptions implicit to the CMB model, which must be met to a degree for the model results to be valid. These assumptions are discussed in general below, but can vary with each sample modeled.

- **Chemical species must add linearly**. This assumption is met for all species included in the model. One potential exception that was included in a few of the model fits is chlorine. This element may not be conserved if the filter acidity is high. The influence of the inclusion of this element is expected to be minimal because of the large number of elements used in most of the model runs (18 to 20 elements) and it is not a key-fitting element.

- **Measurement uncertainties must be random, uncorrelated and normally distributed**. The sampling and analysis measurement errors are expected to be generally random, uncorrelated and normally distributed.

- **Source profiles must be linearly independent**. Not all of the source profiles in the Boise source profile library are independent. However, none of the linearly dependent profiles were used simultaneously in the model. In each case where collinear sources were used in a common fit, they would appear in the model diagnostics report and the fit was changed until the collinearity was removed.

- **Number of sources must be less than the number of species**. The number of sources used in a model run was always substantially less than the number of species as indicated by the degrees of freedom. The number of degrees of freedom typically exceeded 20 for the basic CMB model. Because of the limited number of species included in the EIP-CMB model (4), there was only one (1) degree of freedom.

- **Source compositions must be constant**. This assumption is typically only met to a degree because of the typical variability in source emissions. However, the variability in source composition is typically substantially less than the variability in mass emissions. In this model application, the potential variability in the composition of the emissions is expected to be properly represented by the uncertainties listed in the source profiles.

- **All contributing sources must be included**. The source profiles listed in the Boise source profile library (Task 2) represent about 98% of the PM_{10} emissions in the airshed surrounding the Boise Fire Station No. 5 monitor during the three study days in December 1999.

5.4 Source category impacts

- **Road Dust**.

The road dust SCEs are well defined and generally consistent with the species relationships, meteorology and expected emission pattern as presented in Sections 3 and 4. The CMB SCE uncertainties are typically in the range of 7 to 15% on the higher impact days (Table 4.5). The common variability of the key profile species and the similar iron-normalized ratios of the PM_{10} measurements to those of road dust are strongly supportive of the CMB reported SCEs (Table 3.4 and Figure 3.1). In addition, the time variability of the impacts are consistent with the expected traffic pattern and conceptual model as illustrated in Figure 5.3. The highest road dust concentrations were apportioned on December 22, a clear, fog-free day. The lowest concentrations were reported on Christmas day, a low traffic day with fog and light snow. (Kuhns, 00) In addition the diurnal pattern on the 22^{nd} and 24^{th} with the peak road dust concentrations reported during the mid-day sampling period is consistent with this source category. It also needs to be noted that the PM_{10} impacts from this source category are consistent with the simultaneously measured impacts on $PM_{2.5}$ and expected sized distributions for this source category; i.e., about 10 to 15 % of the mass in the $PM_{2.5}$ fraction.

- **Wood Combustion**

The wood combustion source category was either the largest or the second largest contributor to primary PM_{10} on all days modeled. This source is responsible for most of the organic carbon and much of the elemental carbon, which represents about 80% of the mass in the emissions from this source. The only other major source of these two species in the Boise airshed is diesel exhaust. As such, wood combustion impacts were closely correlated with measured carbon fraction of PM_{10}. The accuracy of the SCEs for this source category depends strongly on the accuracy of the organic and elemental carbon measurements and their consistency with the source profiles considered. The basic CMB reported uncertainties ranged from about 15 to 30% for this source category but was generally unable to resolve other source categories like mobile source emissions with high carbon content (Appendix B). The impacts from this source were consistent with the meteorology and expected emissions pattern for the period studied in December 1999. During this period (Figure 5.3), the primary PM_{10} impact from wood combustion increased by about 40% even though the primary PM_{10} impacts from road dust and mobile sources decreased. The decreasing primary PM_{10} impacts from the mobile source categories are consistent with the decreasing emissions and increased ventilation. The increase in primary PM_{10} impacts from wood combustion is consistent with this sources expected increase in emissions on Christmas Eve and on Christmas day. The overall uncertainty in the wood combustion SCEs has been estimated to be about 30%.

- **Gasoline Powered Vehicles**.

In general, the basic CMB was unable to resolve primary PM_{10} impacts from this source category. It did resolve a small (0.2 $\mu g/m^3$) leaded gasoline vehicles impact on three days in 1991. This level of impact is consistent with the phasing out of leaded gasoline during this period, and would be consistent with the expected low primary impacts from unleaded gasoline powered vehicles. The reported SCEs for this source category are based on the CMB-EIS model and depend primarily on the accuracy of the emission inventory ratio of PM_{10} to CO and the stability of this ratio over about a 24-hour period. The primary PM_{10} impacts for this source category were about 1 $\mu g/m^3$ during the December study period and about 4 $\mu g/m^3$ on the days modeled in 1991.

The largest component of this source category's impact was secondary PM_{10}. The accuracy of the apportionment of this component depends on the accuracy of the source category relative emission rates for sulfate and nitrate precursor species. It is important to note that this apportionment depends on inter-category relative emission rates, and as such may have significant uncertainties due to differences in the time, elevation, and location of the different categories of emissions. These uncertainties in emissions are expected to be substantially larger than the intra-category PM_{10} to CO relative emission rates used to apportion the primary PM_{10} component of this source categories impact. Use of 1999 emission inventory factors to apportion 1991 impacts adds further uncertainty to these SCEs. The uncertainty in the total SCE is estimated at about 30%.

- **Diesel Powered Vehicles**.

The total impact from diesel-powered vehicles was about the same as that from gasoline-powered vehicles. However, the primary particulate fraction of the diesel SCE was substantially greater than that for gasoline powered vehicles. In the case of diesel powered vehicles, the secondary particle component ranged from a low of about 30% on December 22, 1999 to a high of about 80% on January 7, 1991. The primary particle fraction of this source category's impact was based on the diesel to gasoline emission inventory ratio for PM_{10} emissions. Although this is an inter-category ratio, it is within the mobile category and will have some common emission characteristics. The uncertainty in the SCEs for this source category is estimated to be about 30% for typical weekdays. However, as noted in Section 4.0, the difference in the SCEs from the CMB-EIS model were not in agreement with the EIP-CMB SCEs, nor were they in agreement with expected emission activities. Thus, the CMB-EIS SCEs are not expected to accurately represent diesel vehicle impacts on Christmas Day. The EIP-CMB impacts listed in Table 4.8 are expected to more accurately represent diesel impacts on Christmas Day.

The primary component of this source category's impact, as well as that of gasoline vehicles, decreased over the three December days studied. The secondary component, however, increased over the same period even though there was better airshed ventilation on Christmas Day (Kuhns, 00). This suggests that a more aged air mass returned on Christmas Day.

- **Other Combustion**.

The SCEs for this source category is based on emission inventory scaling of wood combustion and other fuel combustion sources. It does not include residential MSW open burning, which is the only other potentially significant source in this category. This source was excluded because of the assumed low activity in this area over the Christmas holiday period. The relative apportionment of these two source categories are expected to be as accurate as their relative emission inventories. Characteristics of these emissions are expected to be reasonably similar and consistent over typical PM_{10} episode days. This source category is responsible for most of the stationary combustion nitrate and sulfate based on the NOx and SOx emissions, but only a small fraction of the primary PM_{10} impact.

- **Non-Road Sources**.

This source category was not included in the emission inventory scaling, in part because of the expected high uncertainty in these emissions on the days modeled and in part because these emissions are expected to be generally located outside the urban center of Boise.

- **Industrial Sources**.

A specific impact from this source category has not been measured. It has been estimated to be less than about 0.5 µg/m3 or less than about 1% of the PM_{10} mass. Amalgamated sugar is, by far, the largest single source of both primary and secondary particulate precursor species. It is located just north of Nampa, about 20 miles from the attainment demonstration monitoring site at the Boise number 5 fire station. Not only are the emissions from this source introduced to the valley a long way from the monitor, but they are introduced at elevations that could exceed the mixing layer during typical PM_{10} episode days. In addition, as indicated in the conceptual model, these emissions will drain away from the monitor about two thirds of the day when the inversion is lowest, and to the southeast towards Cloverdale during most of the rest of the day when ventilation is greatest and formation of sulfate is lowest because of the reduced humidity. In addition, the emissions from Amalgamated Sugar have a relatively unique profile for the EIP-CMB modeling and would have been relatively well defined if it had been significant. Sulfur is the profile-limiting species for Amalgamated Sugar. As such, the maximum impact this source might have made was limited to a small fraction of this species. However, not only couldn't it be resolved by the EIP-CMB model, but a significant influence was not detected in the sulfate and nitrate regression plots for the days studied.

- **Secondary PM**

The secondary particle component of PM_{10} ranged from a low of almost 7% on December 22, 1999 to a high of almost 70% on January 7, 1991 at the Boise Mountain View School. The 1991 winter PM_{10} episode days are characterized by high (>50%) secondary PM_{10} contributions. Apportionment of this large fraction of PM_{10} has been based on emission inventory scaling and the following two assumptions:

- Emissions of precursor species from area and mobile sources in Ada county are responsible for the vast majority of these species, and

- The emissions from these sources are well mixed and have similar meteorological histories.

Thus, the accuracy of the secondary species apportionment to specific source categories is dependent on the accuracy of the emission inventory and the degree to which the above assumptions are satisfied. The high correlation between the 24-hour sulfate and nitrate concentrations on the 1991 episode days, as well as at the other sites suggests not only a common group of sources, but also common daily meteorological histories. As such, uncertainties in the emission inventory are expected to dominate the reported source contribution estimates for these secondary species.

5.5 CMB-EIS and EIP-CMB Models

These models provided reasonably consistent source contribution estimates on the two days preceding Christmas, but not on Christmas Day. The EIP-CMB model appeared to give SCEs more consistent with expectations relative to the preceding two days. This comparison clearly identifies the limitations of the CMB-EIS model that relies on fixed inter-source category ratios, and indicates the potential strength of the EIP-CMB when adequate data is available. This latter modeling approach could easily be expanded to include fitting of more species and source categories.

5.6 Projecting Future Impacts

These modeling results suggest the following conclusions for winter PM10 episode periods in Boise:

- PM_{10} concentrations measured at the BFS5 monitor are dominated by primary and secondary precursor emissions from area and mobile sources in the general area of the monitor.

- These emissions are well mixed and experience similar meteorological histories on PM_{10} episode days.

- Secondary species are responsible for about 60% of the PM_{10} mass.

- About 10% of the NOx and about 90% of the SOx are converted to nitrate and sulfate, respectively (Kuhns, 00).

Thus, future PM_{10} impacts should be proportional to the ratio of future emission inventories relative to the emissions during the winter of 1991, assuming similar meteorology to the two highest 1991 PM_{10} episode days and similar conversion fractions. Future attainment under worst-case meteorological conditions could then be demonstrated by showing control of emissions from these specific source categories.

6.0 CONCLUSIONS

Ambient and source profiles were compared using a basic CMB model as well as two hybrid models that incorporated aspects of the CMB model and aspects of the emission inventory. Application of these models indicated that on the two highest PM_{10} episode days at the BFS5 monitoring site, emissions from gasoline powered vehicles, diesel powered vehicles and wood combustion were responsible for about equal portions of the PM_{10} mass and together accounted for 82% of the mass. Other combustion sources and road dust accounted for 12% and 6%, respectively. Secondary PM species were responsible for about 60% of the PM_{10} mass on these two high PM_{10} episode days in 1991.

The PM_{10} mass, its chemistry and source contributions to the two highest study days in 1999 were not representative of PM_{10} episode days, but provide substantial variability with which to test and evaluate dispersion model applications. December 25, 1999, the lowest PM_{10} day during the 1999 study period, was similar to the 1991 PM_{10} episode days in that the secondary PM_{10} component accounted for 50% of the PM_{10} and road dust accounted for 6% of the mass. On this day, about 10% of the NOx and about 90% of the SOx were converted to nitrate and sulfate, respectively.

Model and statistical analysis results suggests that PM_{10} concentrations measured at the BFS5 monitor are dominated by well-mixed primary and secondary precursor emissions from area and mobile sources in the general area of the monitor. Based on these conclusions, future PM_{10} impacts should be proportional to the ratio of future emission inventories relative to the emissions during the winter of 1991, assuming similar meteorology to the two highest 1991 PM_{10} episode days and similar conversion fractions to those measured on December 25, 1999. Future attainment under worst-case meteorological conditions could then be demonstrated by showing control of emissions from these specific source categories.

Impacts from industrial sources were estimated to be less than 0.5 $\mu g/m^3$ or less than about 1% on these high PM_{10} days.

The above conclusions are relevant only to the attainment demonstration monitoring site at the Boise Number 5 Fire Station.

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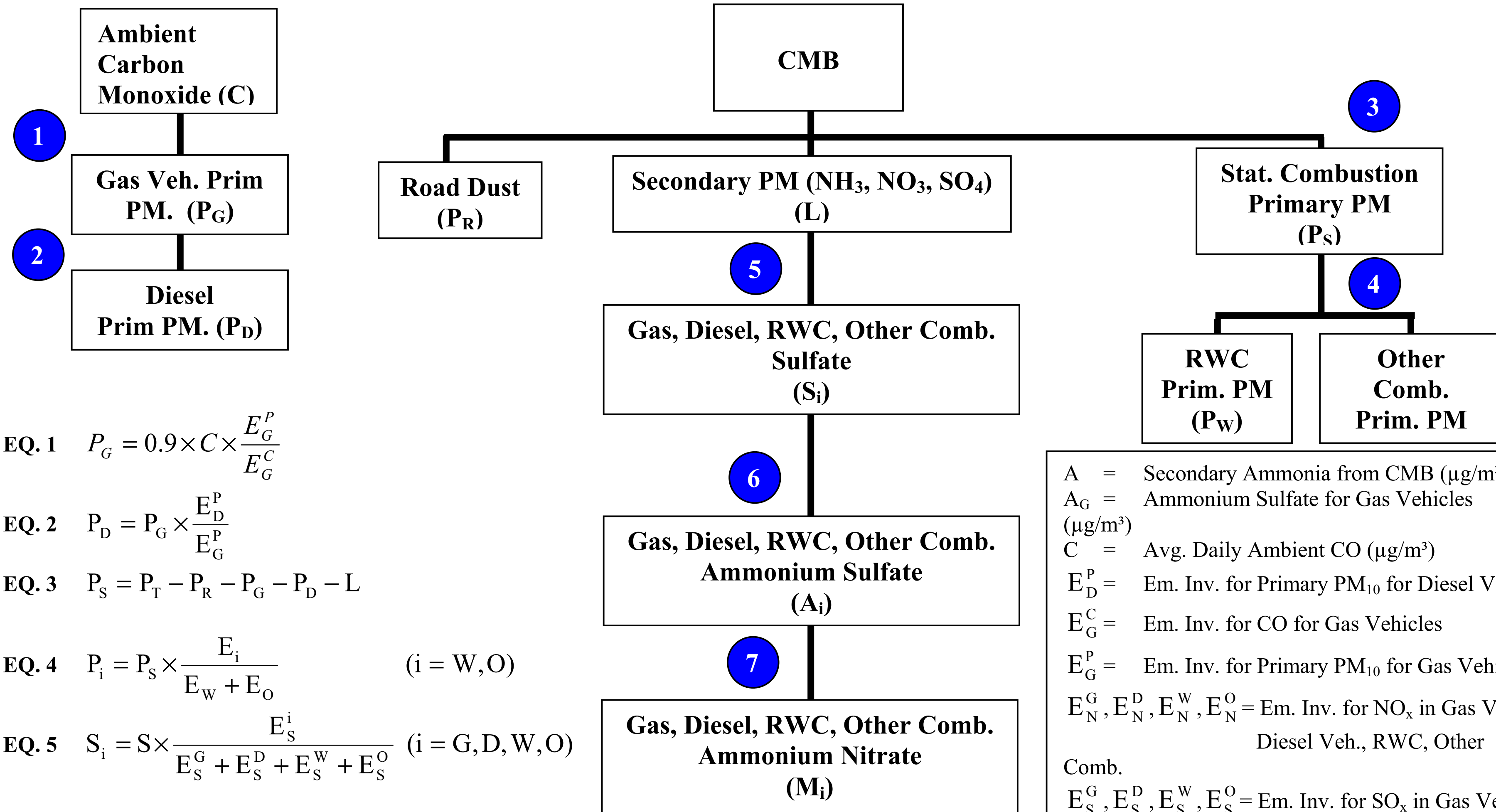
APPENDIX A.

Calculations Used to Determine CMB-EIS Results

Figure A1. Calculation Flow Diagram for CMB-EIS



EQ. 1 $$P_G = 0.9 \times C \times \frac{E_G^P}{E_G^C}$$

EQ. 2 $$P_D = P_G \times \frac{E_D^P}{E_G^P}$$

EQ. 3 $$P_S = P_T - P_R - P_G - P_D - L$$

EQ. 4 $$P_i = P_S \times \frac{E_i}{E_W + E_O} \qquad (i = W, O)$$

EQ. 5 $$S_i = S \times \frac{E_S^i}{E_S^G + E_S^D + E_S^W + E_S^O} \qquad (i = G, D, W, O)$$

EQ. 6 $$A_i = 1.375 \times S_i \qquad (i = G, D, W, O)$$

EQ. 7 $$M_i = \left((A + S + N) - (A_G + A_D + A_W + A_O)\right) \times \frac{E_N^i}{E_N^G + E_N^D + E_N^W + e_N^O} \qquad (i = G, D, W, O)$$

A = Secondary Ammonia from CMB (µg/m³)
A_G = Ammonium Sulfate for Gas Vehicles (µg/m³)
C = Avg. Daily Ambient CO (µg/m³)
E_D^P = Em. Inv. for Primary PM_{10} for Diesel Veh.
E_G^C = Em. Inv. for CO for Gas Vehicles
E_G^P = Em. Inv. for Primary PM_{10} for Gas Vehicles
$E_N^G, E_N^D, E_N^W, E_N^O$ = Em. Inv. for NO_x in Gas Veh., Diesel Veh., RWC, Other Comb.
$E_S^G, E_S^D, E_S^W, E_S^O$ = Em. Inv. for SO_x in Gas Veh., Diesel Veh., RWC, Other Comb.
E_O = Em. Inv. Other Comb.
E_W = Em. Inv. Residential Wood Comb.
L = Secondary species from CMB results (µg/m³)
M_i = Ammonium Nitrate for comb. source (µg/m³)
N = Secondary Nitrate from CMB (µg/m³)
N_G = Nitrate for Gas Vehicles
P_D = Primary PM_{10} for Diesel Vehicles (µg/m³)

Sample Calculation for CMB-EIS Model

Date:	December 24, 1999
Total PM_{10} Measured:	69 µg/m³

Primary PM_{10} -- Road Dust

From CMB:

$\mathbf{P_R}$	=	**23.82 µg/m³**

Primary PM_{10} – Gasoline Vehicles

Equation 1. $$P_G = 0.9 \times C \times \frac{E_G^P}{E_G^C}$$

Where:

P_G	=	Primary PM_{10} for Gasoline Vehicles (µg/m³)
C	=	Avg. Daily Ambient CO (µg/m³)
E_G^P	=	Em. Inv. for Primary PM_{10} for Gas Vehicles
E_G^C	=	Em. Inv. for CO for Gas Vehicles

Ambient [CO] was 1.66 ppm or 1,904 µg/m³
Emission Inventory for PM_{10} was 266 lb/day
Emission Inventory for CO was 398,458 lb/day

$\mathbf{P_G}$	=	**1.14 µg/m³**

Primary PM_{10} – Diesel Vehicles

Equation 2. $$P_D = P_G \times \frac{E_D^P}{E_G^P}$$

Where:

P_D	=	Primary PM_{10} for Diesel Vehicles (µg/m³)
E_D^P	=	Emission Inventory for Primary PM_{10} for Diesel Vehicles

Emission Inventory for PM_{10} for Diesel Vehicles was 601 lb/day

$\mathbf{P_D}$	=	**2.58 µg/m³**

Primary PM_{10} – Stationary Combustion

Equation 3. $$P_S = P_T - P_R - P_G - P_D - L$$

Where:

P_S	=	Primary PM_{10} for Stationary Combustion (µg/m³)
P_T	=	Measured PM_{10} at Boise Fire Station (µg/m³)
P_R	=	Primary PM for Road Dust (µg/m³)
L	=	Secondary species from CMB results (µg/m³)

Secondary PM_{10} (Ammonium, Nitrate, Sulfate) from CMB was 19.68 µg/m³

P_S	**=**	**21.78 µg/m³**

Primary PM_{10} – Residential Wood Combustion and Other Combustion

Equation 4. $$P_i = P_S \times \frac{E_i}{E_W + E_O} \qquad (i = W, O)$$

Where:

P_i	=	Primary PM_{10} from either Residential Wood Combustion (W) or Other Combustion (O) in µg/m³
E_i	=	Emission Inventory for Primary PM_{10} for either Residential Wood Combustion (W) or Other Combustion (O) in lb/day

Emission Inventory for PM_{10} for Residential Wood Combustion was 4,263 lb/day
Emission Inventory for PM_{10} for Other Combustion was 422 lb/day

P_W	**=**	**19.82 µg/m³**
P_O	**=**	**1.96 µg/m³**

Secondary PM_{10} – Sulfate from Gas Vehicles, Diesel Vehicles, RWC, Other Comb.

Equation 5. $$S_i = S \times \frac{E_S^i}{E_S^G + E_S^D + E_S^W + E_S^O}$$

Where:

S_i	=	Sulfate from combustion (G, D, W, O) (µg/m³)
S	=	Secondary PM_{10} (Sulfate) from CMB (µg/m³)
E_S^i	=	Emission Inventory for SO_x in Gas Vehicles, Diesel Vehicles, RWC, and Other Combustion (lb/day)

Secondary PM_{10} (Sulfate) from CMB was 3.92 µg/m³
Emission Inventory for SO_x in Gas Vehicles was 416 lb/day
Emission Inventory for SO_x in Diesel Vehicles was 122 lb/day
Emission Inventory for SO_x in Residential Wood Combustion was 61 lb/day
Emission Inventory for SO_x in Other Combustion was 225 lb/day

S_G	**=**	**1.98 µg/m³**
S_D	**=**	**0.58 µg/m³**
S_W	**=**	**0.29 µg/m³**
S_O	**=**	**1.07 µg/m³**

Secondary PM_{10} – Ammonium Sulfate from Gas Vehicles, Diesel Vehicles, RWC, Other Combustion

Equation 6. $A_i = 1.375 \times S_i \qquad (i = G, D, W, O)$

Where:

A_i = Ammonium Sulfate from combustion (µg/m³)

A_G	**=**	**2.72 µg/m³**
A_D	**=**	**0.80 µg/m³**
A_W	**=**	**0.40 µg/m³**
A_O	**=**	**1.47 µg/m³**

Secondary PM_{10} – Ammonium Nitrate from Gas Vehicles, Diesel Vehicles, RWC, Other Combustion

Equation 7. $M_i = \left(\left(A + S + N\right) - \left(A_G + A_D + A_W + A_O\right)\right) \times \frac{E_N^i}{E_N^G + E_N^D + E_N^W + E_N^O}$

Where:

M_i = Ammonium Nitrate from combustion in Gas Vehicles (G), Diesel Vehicles (D), Residential Wood Comb. (W), and O. Comb. (O) (µg/m³)

A = Secondary PM_{10} (Ammonium) from CMB (µg/m³)

E_N^i = Emission Inventory for NO_x in lb/day (i = Gas, Diesel, Wood, Other)

Emission Inventory for NO_x in Gas Vehicles was 21,988 lb/day
Emission Inventory for NO_x in Diesel Vehicles was 19,337 lb/day
Emission Inventory for NO_x in Residential Wood Combustion was 409 lb/day
Emission Inventory for NO_x in Other Combustion was 6,253 lb/day
Secondary PM_{10} Ammonium Nitrate from CMB was 3.7 µg/m³

M_G	**=**	**6.55 µg/m³**
M_D	**=**	**5.75 µg/m³**
M_W	**=**	**0.12 µg/m³**
M_O	**=**	**1.86 µg/m³**

Total PM_{10}

Equation 9. $P_T = P_R + P_G + P_D + P_W + P_O + A_G + A_D + A_W + A_O + M_G + M_D + M_W + M_O$

For December 24, 1999:

Symbol	Primary or Secondary	Subcategory	PM10 (µg/m³)	PM10 (%)
P_R	Primary	Road Dust	23.82	34.5
P_G	Primary	Gas Vehicles	1.14	1.7
P_D	Primary	Diesel Vehicles	2.58	3.7
P_W	Primary	Residential Wood Combustion	19.82	28.7
P_O	Primary	Other Combustion	1.96	2.8
A_G	Secondary	Ammonium Sulfate Gas Vehicles	2.72	3.9
A_D	Secondary	Ammonium Sulfate Diesel Vehicles	0.80	1.2
A_W	Secondary	Ammonium Sulfate Residential Wood Combustion	0.40	0.6
A_O	Secondary	Ammonium Sulfate Other Combustion	1.47	2.1
M_G	Secondary	Ammonium Nitrate Gas Vehicles	6.55	9.5
M_D	Secondary	Ammonium Nitrate Diesel Vehicles	5.75	8.3
M_W	Secondary	Ammonium Nitrate Residential Wood Combustion	0.12	0.2
M_O	Secondary	Ammonium Nitrate Other Combustion	1.86	2.7
P_T		**Total PM_{10}**	**69.0**	**100**

APPENDIX B.

Basic CMB Model Results

1

SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/22/99 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .97 PERCENT MASS 99.4
CHI SQUARE .52 DF 22

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
2	TVURD	38.6555	2.6416	14.6336
28	HDDNFR4	4.5097	1.6422	2.7461
71	RWBCOMST	21.6818	4.0227	5.3899
105	AMMON	.6279	.1119	5.6121
106	SULFATE	.7743	.2088	3.7083
107	NITRATE	3.3053	.3901	8.4732

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/22/99 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .97 PERCENT MASS 99.4
CHI SQUARE .52 DF 22

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	70.00100+-	1.40002	69.55452+-	4.24730	.99+-	.06	-.1
C11	NA		.11170+-	.07980	.05528+-	.05088	.49+-	.58	-.6
C12	MG		.00100+-	.00100	.03383+-	.06305	33.83+-	71.55	.5
C13	AL		.00100+-	.00100	1.50993+-	.72638	*****+-	*****	2.1
C14	SI		.00100+-	.00100	6.71362+-	2.98267	*****+-	*****	2.3
C15	P		.00100+-	.00100	.00390+-	.05075	3.90+-	50.90	.1
C16	S		.35557+-	.03123	.33997+-	.03393	.96+-	.13	-.3
C17	CL	*	.10970+-	.06250	.06030+-	.02137	.55+-	.37	-.7
C19	K	*	1.20110+-	.23930	.80927+-	.15713	.67+-	.19	-1.4
C20	CA	*	1.17440+-	.20390	.89429+-	.15129	.76+-	.18	-1.1
C22	TI	*	.14070+-	.04040	.14608+-	.02248	1.04+-	.34	.1
C23	V	*	.00100<	.02860	.00142<	.02434	1.42<	47.31	.0
C24	CR	*	.00100<	.00800	.01225<	.02183	12.25<	*****	.5
C25	MN	*	.03190+-	.00320	.04138+-	.00353	1.30+-	.17	2.0
C26	FE	*	1.55980+-	.07810	1.42796+-	.11133	.92+-	.08	-1.0
C28	NI	*	.00060<	.00220	.00534<	.02170	8.91<	48.72	.2
C29	CU		.02670+-	.00320	.00309+-	.00166	.12+-	.06	-6.6
C30	ZN		.09730+-	.00660	.01622+-	.00911	.17+-	.09	-7.2
C31	GA	*	.00010<	.00530	.00017<	.02219	1.74<	*****	.0
C33	AS	*	.00380<	.00680	.00037<	.00211	.10<	.58	-.5
C34	SE	*	.00010<	.00360	.00004<	.02169	.43<	*****	.0
C35	BR	*	.00440+-	.00260	.00052+-	.00094	.12+-	.22	-1.4
C37	RB	*	.00330+-	.00250	.00438+-	.02169	1.33+-	6.65	.0
C38	SR	*	.01530+-	.00330	.01128+-	.02171	.74+-	1.43	-.2
C39	Y	*	.00100<	.00450	.00129<	.02217	1.29<	22.92	.0
C40	ZR	*	.00480<	.00500	.00586<	.02171	1.22<	4.70	.0
C42	MO	*	.00270<	.01030	.00053<	.00556	.19<	2.19	-.2
C48	CD	*	.00310<	.01860	.00064<	.02313	.21<	7.56	-.1
C50	SN	*	.00670<	.02720	.00398<	.02414	.59<	4.34	-.1
C56	BA	*	.06300<	.13770	.04339<	.05447	.69<	1.74	-.1
C82	PB	*	.00870+-	.00830	.00444+-	.00305	.51+-	.60	-.5
C201	OC	*	12.67750+-	.85270	12.75669+-	1.57251	1.01+-	.14	.0
C202	EC	*	5.82210+-	.35440	5.83304+-	1.07385	1.00+-	.19	.0
C203	SO4	*	1.06670+-	.09370	1.06670+-	.18548	1.00+-	.19	.0
C204	NO3	*	3.40010+-	.18700	3.40010+-	.34226	1.00+-	.11	.0
C205	NH4	*	.70290+-	.03680	.70290+-	.10540	1.00+-	.16	.0
C219	K2	*	.16370+-	.00840	.22516+-	.27597	1.38+-	1.69	.2

SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/24/99 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .98 PERCENT MASS 88.8
CHI SQUARE .35 DF 23

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
1	TVPRD	23.8249	2.1493	11.0851
64	RWBCOMTV	17.7555	4.5793	3.8774
105	AMMON	3.6946	.4537	8.1430
106	SULFATE	3.9178	.4791	8.1766
107	NITRATE	12.0665	1.3689	8.8147

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/24/99 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .98 PERCENT MASS 88.8
CHI SQUARE .35 DF 23

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	69.00100+-	1.38002	61.25939+-	4.67761	.89+-	.07	-1.6
C11	NA		.06600<	.07970	.06736<	.12358	1.02<	2.24	.0
C12	MG		.00100+-	.00100	.04419+-	.03834	44.19+-	58.51	1.1
C13	AL		.00100+-	.00100	.83492+-	.43997	*****+-	*****	1.9
C14	SI		.00100+-	.00100	3.53885+-	1.78232	*****+-	*****	2.0
C15	P		.00100+-	.00100	.00475+-	.00899	4.75+-	10.17	.4
C16	S		1.35880+-	.07280	1.48066+-	.15549	1.09+-	.13	.7
C17	CL	*	.11390+-	.06410	.40813+-	.56073	3.58+-	5.32	.5
C19	K	*	.69610+-	.13930	.64219+-	.29820	.92+-	.47	-.2
C20	CA	*	.59220+-	.11170	.51221+-	.14175	.86+-	.29	-.4
C22	TI	*	.06130+-	.03990	.09284+-	.01894	1.51+-	1.03	.7
C23	V	*	.00100<	.02820	.00221<	.00946	2.21<	63.03	.0
C24	CR	*	.00100<	.00780	.00301<	.00191	3.01<	23.54	.2
C25	MN	*	.01340+-	.00280	.01890+-	.00298	1.41+-	.37	1.3
C26	FE	*	.87530+-	.04390	.85259+-	.07248	.97+-	.10	-.3
C28	NI	*	.00130<	.00210	.00433<	.00952	3.33<	9.08	.3
C29	CU		.01630+-	.00300	.00402+-	.00650	.25+-	.40	-1.7
C30	ZN		.05000+-	.00510	.02669+-	.02102	.53+-	.42	-1.1
C31	GA	*	.00020<	.00520	.00034<	.00152	1.72<	45.40	.0
C33	AS	*	.00230<	.00690	.00061<	.00183	.26<	1.12	-.2
C34	SE	*	.00070<	.00370	.00010<	.00085	.14<	1.41	-.2
C35	BR	*	.00360+-	.00270	.00197+-	.00326	.55+-	.99	-.4
C37	RB	*	.00270+-	.00250	.00291+-	.00087	1.08+-	1.05	.1
C38	SR	*	.01340+-	.00330	.00673+-	.00141	.50+-	.16	-1.9
C39	Y	*	.00100<	.00450	.00067<	.00107	.67<	3.20	-.1
C40	ZR	*	.00500+-	.00500	.00352+-	.00184	.70+-	.79	-.3
C42	MO	*	.00460<	.01020	.00040<	.00247	.09<	.57	-.4
C48	CD	*	.00100<	.01860	.00327<	.00883	3.27<	61.41	.1
C50	SN	*	.00480<	.02700	.00227<	.01120	.47<	3.54	-.1
C56	BA	*	.07620<	.13730	.02773<	.04677	.36<	.90	-.3
C82	PB	*	.01190+-	.00830	.00697+-	.00348	.59+-	.50	-.5
C201	OC	*	12.28920+-	.82890	13.10292+-	2.56258	1.07+-	.22	.3
C202	EC	*	4.65210+-	.28500	3.18776+-	2.06569	.69+-	.45	-.7
C203	SO4	*	4.07640+-	.21840	4.07640+-	.42476	1.00+-	.12	.0
C204	NO3	*	12.16670+-	.62130	12.16670+-	1.21968	1.00+-	.11	.0
C205	NH4	*	3.87430+-	.19670	3.87430+-	.40702	1.00+-	.12	.0
C219	K2	*	.18980+-	.00980	.18048+-	.21984	.95+-	1.16	-.0

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/25/99 CMB7 33889

SAMPLE DURATION	24	START HOUR	0	SIZE:	ALL
R SQUARE	.99	PERCENT MASS	95.9		
CHI SQUARE	.14	DF	23		

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
1	TVPRD	2.1532	.2363	9.1118
71	RWBCOMST	15.4800	2.2525	6.8725
105	AMMON	3.5769	.4049	8.8332
106	SULFATE	2.5235	.3175	7.9476
107	NITRATE	11.7357	1.3201	8.8897

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/25/99 CMB7 33889

SAMPLE DURATION	24	START HOUR	0	SIZE:	ALL
R SQUARE	.99	PERCENT MASS	95.9		
CHI SQUARE	.14	DF	23		

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	37.00100+-	.74002	35.46931+-	2.63444	.96+-	.07	-.6
C11	NA		.03930<	.08030	.00770<	.01231	.20<	.51	-.4
C12	MG		.00100+-	.00100	.00274+-	.00444	2.74+-	5.22	.4
C13	AL		.00100+-	.00100	.07366+-	.04036	73.66+-	84.00	1.8
C14	SI		.00100+-	.00100	.31666+-	.16071	*****+-	*****	2.0
C15	P		.00100+-	.00100	.00012+-	.01549	.12+-	15.49	-.1
C16	S		.86660+-	.05057	.86765+-	.08445	1.00+-	.11	.0
C17	CL	*	.02240<	.03000	.01839<	.00486	.82<	1.12	-.1
C19	K	*	.08810+-	.02370	.08244+-	.02127	.94+-	.35	-.2
C20	CA	*	.05350+-	.05170	.04120+-	.00817	.77+-	.76	-.2
C22	TI	*	.00100<	.05410	.00828<	.00850	8.28<	*****	.1
C23	V	*	.00100<	.02840	.00013<	.01550	.13<	15.96	-.0
C24	CR	*	.00100<	.00790	.00025<	.01548	.25<	15.61	-.0
C25	MN	*	.00100<	.00410	.00172<	.00065	1.72<	7.08	.2
C26	FE	*	.07710+-	.00430	.07731+-	.00710	1.00+-	.11	.0
C28	NI	*	.00100<	.00210	.00018<	.01548	.18<	15.49	-.1
C29	CU		.05160+-	.00390	.00060+-	.00109	.01+-	.02	-12.6
C30	ZN		.01900+-	.00460	.00534+-	.00527	.28+-	.29	-2.0
C31	GA	*	.00010<	.00530	.00002<	.01548	.15<	*****	.0
C33	AS	*	.00100<	.00670	.00019<	.00095	.19<	1.58	-.1
C34	SE	*	.00010<	.00360	.00001<	.01548	.06<	*****	.0
C35	BR	*	.00100<	.00340	.00017<	.00049	.17<	.75	-.2
C37	RB	*	.00050<	.00340	.00023<	.01548	.46<	31.12	-.0
C38	SR	*	.00080<	.00410	.00055<	.01548	.69<	19.67	-.0
C39	Y	*	.00100<	.00450	.00006<	.01548	.06<	15.48	-.1
C40	ZR	*	.00230<	.00650	.00027<	.01548	.12<	6.74	-.1
C42	MO	*	.00300<	.01030	.00016<	.00172	.05<	.60	-.3
C48	CD	*	.00100<	.01850	.00002<	.01549	.02<	15.50	-.0
C50	SN	*	.00280<	.02710	.00006<	.01551	.02<	5.54	-.1
C56	BA	*	.00100<	.13830	.00363<	.02672	3.63<	*****	.0
C82	PB	*	.00680<	.01060	.00073<	.00172	.11<	.30	-.6
C201	OC	*	6.94550+-	.51070	7.63786+-	1.04129	1.10+-	.17	.6
C202	EC	*	2.75100+-	.17420	1.69535+-	.69393	.62+-	.26	-1.5
C203	SO4	*	2.59980+-	.15170	2.59980+-	.27876	1.00+-	.12	.0
C204	NO3	*	11.77460+-	.60160	11.77460+-	1.17522	1.00+-	.11	.0
C205	NH4	*	3.60830+-	.18340	3.60830+-	.36104	1.00+-	.11	.0
C219	K2	*	.12210+-	.00630	.12115+-	.19700	.99+-	1.61	.0

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/22/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 0 SIZE: ALL
R SQUARE .99 PERCENT MASS 99.5
CHI SQUARE .19 DF 21

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
3	TVSRD	4.5572	.4593	9.9222
28	HDDNFR4	5.4286	1.1646	4.6615
49	PBSS	.0460	.0148	3.0988
74	RWBHWSTO	10.8296	1.6895	6.4100
105	AMMON	.6353	.1035	6.1388
106	SULFATE	.4877	.0770	6.3365
107	NITRATE	2.2148	.2553	8.6746

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/22/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 0 SIZE: ALL
R SQUARE .99 PERCENT MASS 99.5
CHI SQUARE .19 DF 21

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	24.30940+-	1.27680	24.19923+-	1.80164	1.00+-	.09	-.0
C11	NA		.01840+-	.01480	.05671+-	.05693	3.08+-	3.96	.7
C12	MG		.08690+-	.04050	.00559+-	.05711	.06+-	.66	-1.2
C13	AL		.11380+-	.01220	.19368+-	.12010	1.70+-	1.07	.7
C14	SI		.59800+-	.08180	.78641+-	.40549	1.32+-	.70	.5
C15	P		.00170<	.00780	.00017<	.05434	.10<	31.97	-.0
C16	S		.19753+-	.01767	.20526+-	.01888	1.04+-	.13	.3
C17	CL	*	.09090+-	.04890	.08731+-	.01395	.96+-	.54	-.1
C19	K	*	.17140+-	.01090	.12939+-	.06528	.75+-	.38	-.6
C20	CA	*	.09150+-	.00860	.11464+-	.02824	1.25+-	.33	.8
C22	TI	*	.00570<	.03940	.01520<	.01104	2.67<	18.53	.2
C23	V	*	.00100<	.01660	.00027<	.00512	.27<	6.79	-.0
C24	CR	*	.00110<	.00400	.00450<	.00120	4.09<	14.91	.8
C25	MN	*	.00350+-	.00220	.00444+-	.00091	1.27+-	.84	.4
C26	FE	*	.17560+-	.01380	.16560+-	.01280	.94+-	.10	-.5
C28	NI	*	.00050<	.00180	.00185<	.00052	3.70<	13.35	.7
C29	CU		.01560+-	.00170	.00113+-	.00054	.07+-	.04	-8.1
C30	ZN		.02710+-	.00250	.00520+-	.00668	.19+-	.25	-3.1
C31	GA	*	.00010<	.00290	.00006<	.01213	.64<	*****	.0
C33	AS	*	.00030<	.00360	.00008<	.00107	.28<	4.87	-.1
C34	SE	*	.00010<	.00180	.00001<	.00053	.06<	5.40	-.1
C35	BR	*	.00460+-	.00130	.00402+-	.00070	.87+-	.29	-.4
C37	RB	*	.00050<	.00160	.00060<	.00044	1.21<	3.96	.1
C38	SR	*	.00120<	.00170	.00152<	.00051	1.27<	1.84	.2
C39	Y	*	.00100<	.00210	.00004<	.01213	.04<	12.13	-.1
C40	ZR	*	.00100<	.00250	.00057<	.00078	.57<	1.63	-.2
C42	MO	*	.00100<	.00460	.00022<	.01216	.22<	12.21	-.1
C48	CD	*	.00340<	.01670	.00000<	.01263	.00<	3.71	-.2
C50	SN	*	.00100<	.02430	.00159<	.01316	1.59<	40.83	.0
C56	BA	*	.02630<	.09840	.00000<	.02560	.00<	.97	-.3
C82	PB	*	.00550+-	.00380	.00795+-	.00189	1.45+-	1.06	.6
C201	OC	*	10.44560+-	1.19340	10.73723+-	.81253	1.03+-	.14	.2
C202	EC	*	5.17900+-	.66600	5.15433+-	.55916	1.00+-	.17	-.0
C203	SO4	*	.59260+-	.05300	.59260+-	.05487	1.00+-	.13	.0
C204	NO3	*	2.22220+-	.12650	2.22220+-	.22180	1.00+-	.11	.0
C205	NH4	*	.66170+-	.05840	.66170+-	.08539	1.00+-	.16	.0
C219	K2	*	.09310+-	.01150	.05921+-	.03940	.64+-	.43	-.8

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/22/99 CMB7 33889

SAMPLE DURATION 5 START HOUR 5 SIZE: ALL

R SQUARE .99 PERCENT MASS 100.6

CHI SQUARE .30 DF 21

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
3	TVSRD	7.0596	.6239	11.3150
28	HDDNFR4	7.1369	1.4554	4.9038
49	PBSS	.0360	.0152	2.3755
74	RWBHWSTO	9.4610	1.6905	5.5965
105	AMMON	.9877	.1434	6.8872
106	SULFATE	.8308	.1103	7.5353
107	NITRATE	3.1467	.3583	8.7819

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/22/99 CMB7 33889

SAMPLE DURATION 5 START HOUR 5 SIZE: ALL

R SQUARE .99 PERCENT MASS 100.6

CHI SQUARE .30 DF 21

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	28.48370+-	1.47690	28.65870+-	1.98008	1.01+-	.09	.1
C11	NA		.02040+-	.01480	.08450+-	.07391	4.14+-	4.71	.9
C12	MG		.01970<	.04750	.00811<	.07635	.41<	4.00	-.1
C13	AL		.19330+-	.01540	.29985+-	.18063	1.55+-	.94	.6
C14	SI		.81230+-	.08640	1.21743+-	.62657	1.50+-	.79	.6
C15	P		.01340+-	.00430	.00013+-	.07145	.01+-	5.33	-.2
C16	S		.31377+-	.02153	.32355+-	.03013	1.03+-	.12	.3
C17	CL	*	.12750+-	.05160	.12786+-	.02028	1.00+-	.44	.0
C19	K	*	.18690+-	.01180	.17294+-	.08179	.93+-	.44	-.2
C20	CA	*	.14030+-	.01020	.17681+-	.04363	1.26+-	.32	.8
C22	TI	*	.00410<	.03850	.02348<	.01468	5.73<	53.88	.5
C23	V	*	.00100<	.01630	.00034<	.00703	.34<	8.96	-.0
C24	CR	*	.00050<	.00390	.00694<	.00161	13.87<	*****	1.5
C25	MN	*	.00660+-	.00220	.00644+-	.00113	.98+-	.37	-.1
C26	FE	*	.27590+-	.01750	.25524+-	.01954	.93+-	.09	-.8
C28	NI	*	.00040<	.00180	.00286<	.00067	7.14<	32.19	1.3
C29	CU		.01130+-	.00150	.00172+-	.00068	.15+-	.06	-5.8
C30	ZN		.05320+-	.00340	.00709+-	.00857	.13+-	.16	-5.0
C31	GA	*	.00010<	.00270	.00009<	.01190	.89<	*****	.0
C33	AS	*	.00100<	.00350	.00008<	.00140	.08<	1.43	-.2
C34	SE	*	.00010<	.00170	.00001<	.00070	.08<	7.14	-.1
C35	BR	*	.00310+-	.00130	.00320+-	.00078	1.03+-	.50	.1
C37	RB	*	.00040<	.00150	.00087<	.00059	2.18<	8.32	.3
C38	SR	*	.00220+-	.00130	.00235+-	.00068	1.07+-	.70	.1
C39	Y	*	.00030<	.00200	.00006<	.01188	.21<	39.62	-.0
C40	ZR	*	.00050<	.00240	.00089<	.00105	1.78<	8.80	.1
C42	MO	*	.00200<	.00430	.00035<	.01197	.17<	6.00	-.1
C48	CD	*	.00050<	.01630	.00000<	.01307	.00<	26.15	-.0
C50	SN	*	.00120<	.02320	.00246<	.01427	2.05<	41.44	.0
C56	BA	*	.04530<	.09570	.00000<	.03689	.00<	.81	-.4
C82	PB	*	.00740+-	.00370	.00696+-	.00219	.94+-	.56	-.1
C201	OC	*	9.91870+-	1.14110	10.10818+-	.87801	1.02+-	.15	.1
C202	EC	*	6.42920+-	.82400	6.39865+-	.71653	1.00+-	.17	-.0
C203	SO4	*	.94130+-	.06460	.94130+-	.08875	1.00+-	.12	.0
C204	NO3	*	3.15610+-	.17080	3.15610+-	.31503	1.00+-	.11	.0
C205	NH4	*	1.01660+-	.07270	1.01660+-	.12360	1.00+-	.14	.0
C219	K2	*	.07850+-	.01020	.05450+-	.03620	.69+-	.47	-.6

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/22/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	10	SIZE:	ALL
R SQUARE	.97	PERCENT MASS	123.2		
CHI SQUARE	.74	DF	22		

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
3	TVSRD	11.9018	.9427	12.6254
28	HDDNFR4	3.2123	.8045	3.9927
74	RWBHWSTO	8.8784	1.6583	5.3539
105	AMMON	1.4725	.1845	7.9800
106	SULFATE	.6545	.0985	6.6456
107	NITRATE	6.5933	.7444	8.8571

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/22/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	10	SIZE:	ALL
R SQUARE	.97	PERCENT MASS	123.2		
CHI SQUARE	.74	DF	22		

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	26.54320+-	1.41520	32.71284+-	1.92391	1.23+-	.10	2.6
C11	NA		.03330+-	.01870	.13922+-	.04212	4.18+-	2.67	2.3
C12	MG		.02220<	.06110	.01314<	.05576	.59<	2.99	-.1
C13	AL		.37330+-	.02460	.50522+-	.28158	1.35+-	.76	.5
C14	SI		1.50880+-	.12220	2.05136+-	1.04994	1.36+-	.70	.5
C15	P		.00030<	.01080	-.00000<	.03262	-.01<	*****	.0
C16	S		.25557+-	.02240	.25879+-	.02357	1.01+-	.13	.1
C17	CL	*	.09080+-	.05990	.20684+-	.03328	2.28+-	1.55	1.7
C19	K	*	.30520+-	.01780	.26493+-	.06438	.87+-	.22	-.6
C20	CA	*	.29200+-	.01760	.29287+-	.07328	1.00+-	.26	.0
C22	TI	*	.02680<	.04860	.03948<	.02182	1.47<	2.79	.2
C23	V	*	.00260<	.02050	.00046<	.01076	.18<	4.36	-.1
C24	CR	*	.00060<	.00500	.01166<	.00235	19.44<	*****	2.0
C25	MN	*	.01060+-	.00280	.01013+-	.00159	.96+-	.29	-.1
C26	FE	*	.46230+-	.02680	.42705+-	.03263	.92+-	.09	-.8
C28	NI	*	.00070<	.00230	.00479<	.00095	6.84<	22.53	1.6
C29	CU		.01210+-	.00190	.00287+-	.00094	.24+-	.09	-4.4
C30	ZN		.06600+-	.00430	.00581+-	.00420	.09+-	.06	-10.0
C31	GA	*	.00130<	.00350	.00013<	.00962	.10<	7.40	-.1
C33	AS	*	.00100<	.00450	.00001<	.00207	.01<	2.07	-.2
C34	SE	*	.00010<	.00220	.00000<	.00104	.03<	10.42	-.0
C35	BR	*	.00260+-	.00160	.00010+-	.00102	.04+-	.39	-1.3
C37	RB	*	.00130<	.00190	.00140<	.00086	1.08<	1.71	.0
C38	SR	*	.00500+-	.00160	.00395+-	.00100	.79+-	.32	-.6
C39	Y	*	.00050<	.00250	.00011<	.00954	.21<	19.11	-.0
C40	ZR	*	.00230+-	.00230	.00150+-	.00160	.65+-	.95	-.3
C42	MO	*	.00120<	.00550	.00058<	.00986	.49<	8.51	-.1
C48	CD	*	.00130<	.02050	.00000<	.01326	.00<	10.20	-.1
C50	SN	*	.00100<	.02970	.00415<	.01640	4.15<	*****	.1
C56	BA	*	.02920<	.12120	.00000<	.05965	.00<	2.04	-.2
C82	PB	*	.00990+-	.00470	.00254+-	.00297	.26+-	.32	-1.3
C201	OC	*	9.05500+-	1.10760	9.38783+-	.88252	1.04+-	.16	.2
C202	EC	*	3.40770+-	.44280	3.40063+-	.39444	1.00+-	.17	-.0
C203	SO4	*	.76670+-	.06720	.76670+-	.07128	1.00+-	.13	.0
C204	NO3	*	6.59850+-	.34510	6.59850+-	.65967	1.00+-	.11	.0
C205	NH4	*	1.50930+-	.10200	1.50930+-	.15376	1.00+-	.12	.0
C219	K2	*	.10650+-	.01350	.05560+-	.03908	.52+-	.37	-1.2

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/22/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 14 SIZE: ALL
R SQUARE .94 PERCENT MASS 111.0
CHI SQUARE .76 DF 22

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
3	TVSRD	6.5268	.6952	9.3887
28	HDDNFR4	2.2441	.6070	3.6972
74	RWBHWSTO	7.2795	1.3989	5.2039
105	AMMON	.4931	.1086	4.5422
106	SULFATE	.3190	.0952	3.3529
107	NITRATE	1.9826	.2476	8.0063

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/22/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 14 SIZE: ALL
R SQUARE .94 PERCENT MASS 111.0
CHI SQUARE .76 DF 22

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	16.97180+-	1.14370	18.84522+-	1.45672	1.11+-	.11	1.0
C11	NA		.02400<	.02860	.07745<	.02783	3.23<	4.02	1.3
C12	MG		.04860<	.07750	.00739<	.03363	.15<	.73	-.5
C13	AL		.19820+-	.02270	.27706+-	.15504	1.40+-	.80	.5
C14	SI		.84270+-	.15480	1.12504+-	.57594	1.34+-	.73	.5
C15	P		.01090+-	.00670	.00000+-	.02266	.00+-	2.08	-.5
C16	S		.13240+-	.02917	.13520+-	.01213	1.02+-	.24	.1
C17	CL	*	.10500+-	.09100	.11587+-	.01848	1.10+-	.97	.1
C19	K	*	.26420+-	.01840	.15434+-	.04096	.58+-	.16	-2.4
C20	CA	*	.13330+-	.01550	.16089+-	.04020	1.21+-	.33	.6
C22	TI	*	.01840<	.07630	.02167<	.01242	1.18<	4.93	.0
C23	V	*	.00270<	.03220	.00027<	.00606	.10<	2.55	-.1
C24	CR	*	.00070<	.00770	.00641<	.00134	9.15<	*****	.7
C25	MN	*	.00470+-	.00420	.00556+-	.00091	1.18+-	1.08	.2
C26	FE	*	.22220+-	.02350	.23463+-	.01794	1.06+-	.14	.4
C28	NI	*	.00050<	.00350	.00263<	.00055	5.26<	36.81	.6
C29	CU		.00450+-	.00270	.00158+-	.00055	.35+-	.24	-1.1
C30	ZN		.03020+-	.00430	.00354+-	.00299	.12+-	.10	-5.1
C31	GA	*	.00040<	.00550	.00007<	.00768	.18<	19.37	-.0
C33	AS	*	.00100<	.00690	.00001<	.00118	.01<	1.18	-.1
C34	SE	*	.00010<	.00340	.00000<	.00059	.02<	5.96	-.0
C35	BR	*	.00310+-	.00240	.00007+-	.00057	.02+-	.19	-1.2
C37	RB	*	.00060<	.00300	.00079<	.00049	1.31<	6.61	.1
C38	SR	*	.00210<	.00330	.00216<	.00057	1.03<	1.64	.0
C39	Y	*	.00040<	.00410	.00006<	.00766	.15<	19.20	-.0
C40	ZR	*	.00170<	.00490	.00082<	.00090	.48<	1.49	-.2
C42	MO	*	.00160<	.00880	.00032<	.00778	.20<	4.98	-.1
C48	CD	*	.00100<	.03220	.00000<	.00917	.00<	9.17	-.0
C50	SN	*	.00100<	.04660	.00228<	.01059	2.28<	*****	.0
C56	BA	*	.00100<	.19110	.00000<	.03319	.00<	33.19	.0
C82	PB	*	.01020+-	.00730	.00141+-	.00169	.14+-	.19	-1.2
C201	OC	*	6.32150+-	1.04470	7.30385+-	.59338	1.16+-	.21	.8
C202	EC	*	2.46750+-	.35340	2.43605+-	.26979	.99+-	.18	-.1
C203	SO4	*	.39720+-	.08750	.39720+-	.03641	1.00+-	.24	.0
C204	NO3	*	1.98610+-	.14790	1.98610+-	.19865	1.00+-	.12	.0
C205	NH4	*	.51710+-	.09230	.51710+-	.05711	1.00+-	.21	.0
C219	K2	*	.12120+-	.01720	.04276+-	.02860	.35+-	.24	-2.4

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/22/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 19 SIZE: ALL
R SQUARE .97 PERCENT MASS 111.0
CHI SQUARE .14 DF 23

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
1	TVPRD	6.0662	1.4540	4.1721
64	RWBCOMTV	20.9331	5.3073	3.9442
105	AMMON	.5861	.2224	2.6354
106	SULFATE	.3422	.2073	1.6509
107	NITRATE	2.7934	.3845	7.2645

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/22/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 19 SIZE: ALL
R SQUARE .97 PERCENT MASS 111.0
CHI SQUARE .14 DF 23

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	27.68570+-	1.43850	30.72106+-	4.99684	1.11+-	.19	.6
C11	NA		.05080+-	.01560	.06714+-	.14456	1.32+-	2.87	.1
C12	MG		.03220<	.03990	.02721<	.03307	.84<	1.47	-.1
C13	AL		.18700+-	.01490	.23408+-	.11871	1.25+-	.64	.4
C14	SI		.77600+-	.08550	.96670+-	.47886	1.25+-	.63	.4
C15	P		.00810+-	.00400	.00438+-	.00662	.54+-	.86	-.5
C16	S		.17413+-	.01710	.20443+-	.06387	1.17+-	.38	.5
C17	CL	*	.12890+-	.05210	.45143+-	.66065	3.50+-	5.32	.5
C19	K	*	.28980+-	.01640	.37154+-	.33606	1.28+-	1.16	.2
C20	CA	*	.12960+-	.01000	.20150+-	.13324	1.55+-	1.04	.5
C22	TI	*	.00510<	.04160	.02635<	.01049	5.17<	42.19	.5
C23	V	*	.00100<	.01750	.00124<	.00453	1.24<	22.09	.0
C24	CR	*	.00020<	.00420	.00100<	.00104	4.98<	*****	.2
C25	MN	*	.00580+-	.00220	.00629+-	.00300	1.08+-	.66	.1
C26	FE	*	.25160+-	.01650	.23817+-	.05121	.95+-	.21	-.2
C28	NI	*	.00030<	.00190	.00325<	.01120	10.84<	78.14	.3
C29	CU		.01590+-	.00170	.00332+-	.00762	.21+-	.48	-1.6
C30	ZN		.04190+-	.00300	.01965+-	.02474	.47+-	.59	-.9
C31	GA	*	.00010<	.00300	.00025<	.00087	2.52<	76.04	.0
C33	AS	*	.00100<	.00390	.00037<	.00101	.37<	1.76	-.2
C34	SE	*	.00010<	.00190	.00006<	.00052	.58<	12.11	-.0
C35	BR	*	.00410+-	.00130	.00219+-	.00375	.53+-	.93	-.5
C37	RB	*	.00070<	.00170	.00105<	.00069	1.50<	3.78	.2
C38	SR	*	.00190+-	.00130	.00227+-	.00140	1.20+-	1.10	.2
C39	Y	*	.00100<	.00220	.00020<	.00060	.20<	.75	-.3
C40	ZR	*	.00020<	.00270	.00137<	.00178	6.86<	93.08	.4
C42	MO	*	.00100<	.00480	.00041<	.00160	.41<	2.55	-.1
C48	CD	*	.00680<	.01770	.00367<	.00705	.54<	1.75	-.2
C50	SN	*	.01550<	.02550	.00206<	.00687	.13<	.49	-.5
C56	BA	*	.03240<	.10400	.00978<	.02985	.30<	1.34	-.2
C82	PB	*	.00810+-	.00380	.00387+-	.00351	.48+-	.49	-.8
C201	OC	*	11.51230+-	1.29480	11.95191+-	2.95434	1.04+-	.28	.1
C202	EC	*	5.45400+-	.69840	3.47348+-	2.42991	.64+-	.45	-.8
C203	SO4	*	.52240+-	.05130	.52240+-	.19572	1.00+-	.39	.0
C204	NO3	*	2.91040+-	.15910	2.91040+-	.34887	1.00+-	.13	.0
C205	NH4	*	.77440+-	.06290	.77440+-	.20837	1.00+-	.28	.0
C219	K2	*	.15350+-	.01720	.19759+-	.25807	1.29+-	1.69	.2

SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/24/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 0 SIZE: ALL
R SQUARE .98 PERCENT MASS 101.3
CHI SQUARE .16 DF 22

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
4	TVTRD	1.4704	.8270	1.7780
64	RWBCOMTV	25.4062	6.1999	4.0978
105	AMMON	2.8728	.4203	6.8356
106	SULFATE	1.8091	.3204	5.6469
107	NITRATE	9.4338	1.1368	8.2986

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/24/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 0 SIZE: ALL
R SQUARE .98 PERCENT MASS 101.3
CHI SQUARE .16 DF 22

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	40.45850+-	2.06110	40.99229+-	6.08049	1.01+-	.16	.1
C11	NA		.02700+-	.01490	.07855+-	.17538	2.91+-	6.69	.3
C12	MG		.02620<	.04030	.02688<	.03992	1.03<	2.19	.0
C13	AL		.10130+-	.01210	.09829+-	.08621	.97+-	.86	-.0
C14	SI		.43250+-	.07980	.36892+-	.34966	.85+-	.82	-.2
C15	P		.00010<	.01070	.00490<	.00783	49.03<	*****	.4
C16	S		.67527+-	.03720	.67814+-	.09499	1.00+-	.15	.0
C17	CL	*	.23770+-	.06270	.54251+-	.80180	2.28+-	3.43	.4
C19	K	*	.24450+-	.01420	.34506+-	.40713	1.41+-	1.67	.2
C20	CA	*	.08540+-	.00850	.13168+-	.15976	1.54+-	1.88	.3
C22	TI	*	.00360<	.04030	.00919<	.01177	2.55<	28.76	.1
C23	V	*	.00100<	.01690	.00111<	.00497	1.11<	19.44	.0
C24	CR	*	.00090<	.00410	.00047<	.00118	.53<	2.74	-.1
C25	MN	*	.00350+-	.00220	.00371+-	.00361	1.06+-	1.23	.0
C26	FE	*	.14310+-	.01280	.14027+-	.05989	.98+-	.43	-.0
C28	NI	*	.00080<	.00190	.00339<	.01359	4.23<	19.74	.2
C29	CU		.01930+-	.00180	.00413+-	.00925	.21+-	.48	-1.6
C30	ZN		.04040+-	.00300	.02184+-	.03003	.54+-	.74	-.6
C31	GA	*	.00010<	.00290	.00026<	.00099	2.62<	76.58	.1
C33	AS	*	.00100<	.00390	.00033<	.00114	.33<	1.72	-.2
C34	SE	*	.00020<	.00190	.00005<	.00060	.25<	3.85	-.1
C35	BR	*	.00700+-	.00130	.00264+-	.00455	.38+-	.65	-.9
C37	RB	*	.00030<	.00160	.00061<	.00082	2.02<	11.14	.2
C38	SR		.01690+-	.00160	.00142+-	.00168	.08+-	.10	-6.7
C39	Y	*	.00100<	.00220	.00009<	.00069	.09<	.72	-.4
C40	ZR	*	.00040<	.00270	.00145<	.00214	3.63<	25.06	.3
C42	MO	*	.00100<	.00470	.00049<	.00186	.49<	2.97	-.1
C48	CD	*	.00120<	.01710	.00442<	.00833	3.68<	52.94	.2
C50	SN	*	.01190<	.02470	.00229<	.00783	.19<	.77	-.4
C56	BA	*	.02690<	.10080	.00816<	.03425	.30<	1.71	-.2
C82	PB	*	.00920+-	.00380	.00348+-	.00423	.38+-	.49	-1.0
C201	OC	*	12.40750+-	1.38200	13.45293+-	3.58196	1.08+-	.31	.3
C202	EC	*	6.42110+-	.82230	4.17876+-	2.94883	.65+-	.47	-.7
C203	SO4	*	2.02580+-	.11160	2.02580+-	.29565	1.00+-	.16	.0
C204	NO3	*	9.57640+-	.58060	9.57640+-	.97688	1.00+-	.12	.0
C205	NH4	*	3.09410+-	.17990	3.09410+-	.37603	1.00+-	.13	.0
C219	K2	*	.15110+-	.01690	.23615+-	.31332	1.56+-	2.08	.3

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/24/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	5	SIZE:	ALL
R SQUARE	.96	PERCENT MASS	94.9		
CHI SQUARE	.34	DF	24		

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
64	RWBCOMTV	31.9239	7.4610	4.2788
105	AMMON	2.9697	.4698	6.3209
106	SULFATE	2.2928	.4022	5.7001
107	NITRATE	8.9290	1.1028	8.0963

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/24/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	5	SIZE:	ALL
R SQUARE	.96	PERCENT MASS	94.9		
CHI SQUARE	.34	DF	24		

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	48.61880+-	2.46220	46.11536+-	7.39918	.95+-	.16	-.3
C11	NA		.02820+-	.01500	.09724+-	.22037	3.45+-	8.03	.3
C12	MG		.00100<	.04960	.03103<	.04935	31.03<	*****	.4
C13	AL		.11080+-	.01280	.04182+-	.06133	.38+-	.56	-1.1
C14	SI		.50040+-	.08010	.12770+-	.23873	.26+-	.48	-1.5
C15	P		.00080<	.01250	.00616<	.00971	7.70<	*****	.3
C16	S		.85503+-	.04580	.85348+-	.11977	1.00+-	.15	-.0
C17	CL	*	.29570+-	.07010	.67596+-	1.00749	2.29+-	3.45	.4
C19	K	*	.25880+-	.01490	.40464+-	.51133	1.56+-	1.98	.3
C20	CA	*	.09560+-	.00880	.13826+-	.20032	1.45+-	2.10	.2
C22	TI	*	.01080<	.04160	.00527<	.01456	.49<	2.31	-.1
C23	V	*	.00090<	.01750	.00131<	.00600	1.45<	29.05	.0
C24	CR	*	.00100<	.00410	.00045<	.00144	.45<	2.33	-.1
C25	MN	*	.00370+-	.00220	.00287+-	.00453	.78+-	1.31	-.2
C26	FE	*	.17240+-	.01370	.04102+-	.07461	.24+-	.43	-1.7
C28	NI	*	.00100<	.00190	.00418<	.01708	4.18<	18.84	.2
C29	CU		.00800+-	.00150	.00447+-	.01162	.56+-	1.46	-.3
C30	ZN		.04180+-	.00300	.02500+-	.03773	.60+-	.90	-.4
C31	GA	*	.00010<	.00310	.00032<	.00122	3.19<	99.71	.1
C33	AS	*	.00070<	.00420	.00042<	.00141	.59<	4.09	-.1
C34	SE	*	.00010<	.00190	.00006<	.00074	.64<	14.21	-.0
C35	BR	*	.00950+-	.00140	.00329+-	.00572	.35+-	.60	-1.1
C37	RB	*	.00040<	.00180	.00061<	.00103	1.52<	7.29	.1
C38	SR	*	.00330+-	.00130	.00109+-	.00211	.33+-	.65	-.9
C39	Y	*	.00100<	.00230	.00006<	.00084	.06<	.85	-.4
C40	ZR	*	.00020<	.00270	.00093<	.00268	4.63<	63.92	.2
C42	MO	*	.00100<	.00490	.00061<	.00230	.61<	3.76	-.1
C48	CD	*	.00100<	.01750	.00552<	.01044	5.52<	97.21	.2
C50	SN	*	.00100<	.02530	.00287<	.00977	2.87<	73.34	.1
C56	BA	*	.00570<	.10470	.00530<	.04275	.93<	18.65	.0
C82	PB	*	.01100+-	.00390	.00409+-	.00530	.37+-	.50	-1.1
C201	OC	*	13.17960+-	1.45840	16.75858+-	4.50044	1.27+-	.37	.8
C202	EC	*	8.76080+-	1.11930	5.17758+-	3.70531	.59+-	.43	-.9
C203	SO4	*	2.56510+-	.13740	2.56510+-	.37270	1.00+-	.15	.0
C204	NO3	*	9.10780+-	.56210	9.10780+-	.94806	1.00+-	.12	.0
C205	NH4	*	3.24740+-	.18830	3.24740+-	.42558	1.00+-	.14	.0
C219	K2	*	.15050+-	.01690	.29494+-	.39361	1.96+-	2.62	.4

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/24/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	10	SIZE:	ALL
R SQUARE	1.00	PERCENT MASS	107.3		
CHI SQUARE	.09	DF	21		

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
3	TVSRD	6.2220	.6179	10.0699
28	HDDNFR4	3.1031	1.3678	2.2686
49	PBSS	.0503	.0195	2.5760
71	RWBCOMST	15.6511	3.4276	4.5661
105	AMMON	3.5056	.4124	8.5010
106	SULFATE	1.9205	.2565	7.4882
107	NITRATE	10.8663	1.2929	8.4044

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/24/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	10	SIZE:	ALL
R SQUARE	1.00	PERCENT MASS	107.3		
CHI SQUARE	.09	DF	21		

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	38.51240+-	1.99630	41.31876+-	3.30748	1.07+-	.10	.7
C11	NA		.02660+-	.01980	.07723+-	.03605	2.90+-	2.55	1.2
C12	MG		.03550<	.05370	.00683<	.03928	.19<	1.14	-.4
C13	AL		.18130+-	.01730	.26468+-	.14970	1.46+-	.84	.6
C14	SI		.71710+-	.10850	1.07616+-	.54953	1.50+-	.80	.6
C15	P		.00610<	.01340	.00019<	.03488	.03<	5.72	-.2
C16	S		.67770+-	.03953	.66998+-	.06442	.99+-	.11	-.1
C17	CL	*	.14650+-	.06730	.11960+-	.01783	.82+-	.39	-.4
C19	K	*	.19440+-	.01320	.16636+-	.04510	.86+-	.24	-.6
C20	CA	*	.14060+-	.01210	.15587+-	.03838	1.11+-	.29	.4
C22	TI	*	.02340<	.05450	.02076<	.01407	.89<	2.15	-.0
C23	V	*	.00450<	.02290	.00021<	.01661	.05<	3.70	-.2
C24	CR	*	.00030<	.00550	.00608<	.01570	20.27<	*****	.3
C25	MN	*	.00320+-	.00290	.00603+-	.00111	1.88+-	1.74	.9
C26	FE	*	.22890+-	.01830	.22538+-	.01768	.98+-	.11	-.1
C28	NI	*	.00120<	.00260	.00251<	.01566	2.10<	13.82	.1
C29	CU		.02900+-	.00250	.00198+-	.00120	.07+-	.04	-9.7
C30	ZN		.05720+-	.00410	.00825+-	.00646	.14+-	.11	-6.4
C31	GA	*	.00010<	.00400	.00008<	.01598	.84<	*****	.0
C33	AS	*	.00100<	.00500	.00024<	.00144	.24<	1.86	-.1
C34	SE	*	.00010<	.00250	.00000<	.01566	.04<	*****	.0
C35	BR	*	.00490+-	.00170	.00445+-	.00090	.91+-	.37	-.2
C37	RB	*	.00030<	.00220	.00070<	.01566	2.32<	54.90	.0
C38	SR	*	.00430+-	.00180	.00207+-	.01566	.48+-	3.65	-.1
C39	Y	*	.00100<	.00290	.00006<	.01597	.06<	15.97	-.1
C40	ZR	*	.00100<	.00350	.00078<	.01567	.78<	15.91	-.0
C42	MO	*	.00100<	.00640	.00046<	.00385	.46<	4.85	-.1
C48	CD	*	.00100<	.02290	.00000<	.01668	.00<	16.68	-.0
C50	SN	*	.00100<	.03350	.00217<	.01743	2.17<	74.80	.0
C56	BA	*	.02770<	.13640	.00141<	.04092	.05<	1.50	-.2
C82	PB	*	.00770+-	.00510	.00917+-	.00261	1.19+-	.86	.3
C201	OC	*	8.44780+-	1.07170	8.57177+-	1.13105	1.01+-	.19	.1
C202	EC	*	4.19010+-	.54340	4.17921+-	.76965	1.00+-	.22	-.0
C203	SO4	*	2.03310+-	.11860	2.03310+-	.22692	1.00+-	.13	.0
C204	NO3	*	10.90910+-	.69790	10.90910+-	1.08851	1.00+-	.12	.0
C205	NH4	*	3.54740+-	.20860	3.54740+-	.35572	1.00+-	.12	.0
C219	K2	*	.08810+-	.01220	.12652+-	.19944	1.44+-	2.27	.2

SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/24/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 14 SIZE: ALL
R SQUARE .99 PERCENT MASS 107.6
CHI SQUARE .10 DF 23

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
3	TVSRD	2.5022	.9151	2.7342
64	RWBCOMTV	13.9560	3.5522	3.9289
105	AMMON	5.2850	.6178	8.5548
106	SULFATE	5.1070	.6635	7.6972
107	NITRATE	16.7124	1.9093	8.7533

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/24/99 CMB7 33889
SAMPLE DURATION 5 START HOUR 14 SIZE: ALL
R SQUARE .99 PERCENT MASS 107.6
CHI SQUARE .10 DF 23

SPECIES		I	MEAS	CALC	RATIO C/M	RATIO R/U
C1	TOTAL	T	40.48480+- 2.06070	43.56255+- 3.96604	1.08+- .11	.7
C11	NA		.06200+- .01450	.07092+- .09648	1.14+- 1.58	.1
C12	MG		.02170< .04840	.01619< .02360	.75< 1.99	-.1
C13	AL		.08490+- .01200	.12450+- .06463	1.47+- .79	.6
C14	SI		.37040+- .07740	.48701+- .24407	1.31+- .71	.5
C15	P		.00100< .01430	.00269< .00441	2.69< 38.76	.1
C16	S		1.74540+- .13420	1.74399+- .17493	1.00+- .13	.0
C17	CL	*	.21500+- .05940	.33704+- .44049	1.57+- 2.09	.3
C19	K	*	.29290+- .01660	.22558+- .22378	.77+- .77	-.3
C20	CA	*	.06890+- .00810	.12162+- .08892	1.77+- 1.31	.6
C22	TI	*	.01080< .03980	.01058< .00775	.98< 3.68	.0
C23	V	*	.00080< .01670	.00065< .00343	.81< 17.43	.0
C24	CR	*	.00100< .00400	.00264< .00081	2.64< 10.59	.4
C25	MN	*	.00210< .00300	.00338< .00202	1.61< 2.49	.4
C26	FE	*	.11540+- .01190	.10729+- .03333	.93+- .30	-.2
C28	NI	*	.00100< .00190	.00283< .00747	2.83< 9.21	.2
C29	CU		.01530+- .00160	.00255+- .00509	.17+- .33	-2.4
C30	ZN		.02790+- .00250	.01167+- .01650	.42+- .59	-1.0
C31	GA	*	.00010< .00290	.00017< .00068	1.67< 48.93	.0
C33	AS	*	.00020< .00360	.00018< .00077	.91< 16.77	.0
C34	SE	*	.00110< .00190	.00003< .00042	.03< .39	-.6
C35	BR	*	.00230+- .00120	.00144+- .00251	.62+- 1.14	-.3
C37	RB	*	.00070< .00160	.00054< .00051	.78< 1.92	-.1
C38	SR	*	.00210+- .00130	.00130+- .00096	.62+- .60	-.5
C39	Y	*	.00100< .00210	.00005< .00050	.05< .51	-.4
C40	ZR	*	.00030< .00260	.00072< .00123	2.40< 21.20	.1
C42	MO	*	.00100< .00460	.00039< .00118	.39< 2.14	-.1
C48	CD	*	.00100< .01690	.00241< .00497	2.41< 41.10	.1
C50	SN	*	.01090< .02420	.00213< .00512	.20< .64	-.4
C56	BA	*	.00100< .09980	.00232< .02242	2.32< *****	.0
C82	PB	*	.00450+- .00370	.00230+- .00240	.51+- .68	-.5
C201	OC	*	7.18130+- .87410	7.57785+- 1.97228	1.06+- .30	.2
C202	EC	*	2.52780+- .33090	2.30343+- 1.62035	.91+- .65	-.1
C203	SO4	*	5.23620+- .40260	5.23620+- .52663	1.00+- .13	.0
C204	NO3	*	16.79190+- .91280	16.79190+- 1.67704	1.00+- .11	.0
C205	NH4	*	5.41150+- .28930	5.41150+- .54507	1.00+- .11	.0
C219	K2	*	.19800+- .01120	.13112+- .17305	.66+- .87	-.4

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/24/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	19	SIZE:	ALL
R SQUARE	.99	PERCENT MASS	92.7		
CHI SQUARE	.15	DF	24		

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
64	RWBCOMTV	18.3671	4.4184	4.1570
105	AMMON	4.8930	.5955	8.2171
106	SULFATE	4.7482	.5651	8.4030
107	NITRATE	13.4600	1.5578	8.6405

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/24/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	19	SIZE:	ALL
R SQUARE	.99	PERCENT MASS	92.7		
CHI SQUARE	.15	DF	24		

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	44.74920+-	2.27090	41.46827+-	4.66261	.93+-	.11	-.6
C11	NA		.04060+-	.01530	.05595+-	.12679	1.38+-	3.17	.1
C12	MG		.02690<	.04830	.01785<	.02840	.66<	1.59	-.2
C13	AL		.05840+-	.01090	.02406+-	.03528	.41+-	.61	-.9
C14	SI		.19150+-	.07580	.07347+-	.13735	.38+-	.73	-.8
C15	P		.00550<	.01480	.00354<	.00559	.64<	2.01	-.1
C16	S		1.63507+-	.08427	1.63405+-	.16692	1.00+-	.11	.0
C17	CL	*	.20270+-	.05910	.38890+-	.57965	1.92+-	2.91	.3
C19	K	*	.30010+-	.01680	.23280+-	.29419	.78+-	.98	-.2
C20	CA	*	.03580+-	.00740	.07955+-	.11525	2.22+-	3.25	.4
C22	TI	*	.00610<	.04020	.00303<	.00838	.50<	3.55	-.1
C23	V	*	.00170<	.01690	.00075<	.00346	.44<	4.85	-.1
C24	CR	*	.00010<	.00410	.00026<	.00084	2.57<	*****	.0
C25	MN	*	.00160<	.00300	.00165<	.00261	1.03<	2.53	.0
C26	FE	*	.06780+-	.01090	.02360+-	.04292	.35+-	.64	-1.0
C28	NI	*	.00080<	.00190	.00241<	.00983	3.01<	14.21	.2
C29	CU		.00350+-	.00140	.00257+-	.00669	.73+-	1.93	-.1
C30	ZN		.03150+-	.00260	.01438+-	.02171	.46+-	.69	-.8
C31	GA	*	.00010<	.00290	.00018<	.00071	1.84<	53.74	.0
C33	AS	*	.00100<	.00390	.00024<	.00082	.24<	1.24	-.2
C34	SE	*	.00010<	.00190	.00004<	.00045	.37<	8.30	-.0
C35	BR	*	.00320+-	.00130	.00189+-	.00329	.59+-	1.06	-.4
C37	RB	*	.00090<	.00160	.00035<	.00061	.39<	.96	-.3
C38	SR	*	.00120<	.00180	.00062<	.00122	.52<	1.28	-.3
C39	Y	*	.00100<	.00220	.00004<	.00050	.04<	.51	-.4
C40	ZR	*	.00100<	.00260	.00053<	.00155	.53<	2.08	-.2
C42	MO	*	.00100<	.00480	.00035<	.00133	.35<	2.14	-.1
C48	CD	*	.00100<	.01710	.00318<	.00601	3.18<	54.67	.1
C50	SN	*	.00100<	.02460	.00165<	.00562	1.65<	41.05	.0
C56	BA	*	.00100<	.10080	.00305<	.02459	3.05<	*****	.0
C82	PB	*	.00830+-	.00380	.00235+-	.00305	.28+-	.39	-1.2
C201	OC	*	8.48620+-	1.00310	9.64188+-	2.58928	1.14+-	.33	.4
C202	EC	*	3.31970+-	.42770	2.97887+-	2.13181	.90+-	.65	-.2
C203	SO4	*	4.90520+-	.25280	4.90520+-	.50401	1.00+-	.11	.0
C204	NO3	*	13.56370+-	.76240	13.56370+-	1.35843	1.00+-	.11	.0
C205	NH4	*	5.05310+-	.28810	5.05310+-	.51979	1.00+-	.12	.0
C219	K2	*	.19740+-	.02140	.16969+-	.22690	.86+-	1.15	-.1

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/25/99 CMB7 33889

SAMPLE DURATION	10	START HOUR	0	SIZE:	ALL
R SQUARE	.98	PERCENT MASS	88.6		
CHI SQUARE	.15	DF	24		

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
64	RWBCOMTV	14.5797	3.4383	4.2403
105	AMMON	3.5652	.4393	8.1151
106	SULFATE	2.4978	.4434	5.6331
107	NITRATE	10.5941	1.2414	8.5342

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/25/99 CMB7 33889

SAMPLE DURATION	10	START HOUR	0	SIZE:	ALL
R SQUARE	.98	PERCENT MASS	88.6		
CHI SQUARE	.15	DF	24		

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	35.27150+-	1.77410	31.23674+-	3.63568	.89+-	.11	-1.0
C11	NA		.04150+-	.00840	.04441+-	.10064	1.07+-	2.43	.0
C12	MG		.00100<	.02470	.01417<	.02254	14.17<	*****	.4
C13	AL		.02550+-	.00560	.01910+-	.02801	.75+-	1.11	-.2
C14	SI		.09590+-	.03770	.05832+-	.10903	.61+-	1.16	-.3
C15	P		.00180<	.00810	.00281<	.00443	1.56<	7.45	.1
C16	S		.87410+-	.11323	.87334+-	.09330	1.00+-	.17	.0
C17	CL	*	.15840+-	.03650	.30871+-	.46012	1.95+-	2.94	.3
C19	K	*	.19950+-	.01080	.18480+-	.23352	.93+-	1.17	-.1
C20	CA	*	.02070+-	.00380	.06314+-	.09149	3.05+-	4.46	.5
C22	TI	*	.00440<	.01970	.00241<	.00665	.55<	2.88	-.1
C23	V	*	.00080<	.00830	.00060<	.00274	.75<	8.48	-.0
C24	CR	*	.00030<	.00200	.00020<	.00067	.68<	5.05	-.0
C25	MN	*	.00100<	.00150	.00131<	.00207	1.31<	2.86	.1
C26	FE	*	.03220+-	.00540	.01873+-	.03407	.58+-	1.06	-.4
C28	NI	*	.00030<	.00090	.00191<	.00780	6.37<	32.26	.2
C29	CU		.00780+-	.00080	.00204+-	.00531	.26+-	.68	-1.1
C30	ZN		.02000+-	.00150	.01142+-	.01723	.57+-	.86	-.5
C31	GA	*	.00010<	.00140	.00015<	.00057	1.46<	21.18	.0
C33	AS	*	.00100<	.00210	.00019<	.00065	.19<	.76	-.4
C34	SE	*	.00050<	.00090	.00003<	.00035	.06<	.72	-.5
C35	BR	*	.00290+-	.00060	.00150+-	.00261	.52+-	.91	-.5
C37	RB	*	.00020<	.00080	.00028<	.00048	1.39<	6.04	.1
C38	SR	*	.00090+-	.00060	.00050+-	.00097	.55+-	1.14	-.4
C39	Y	*	.00020<	.00110	.00003<	.00040	.15<	2.14	-.1
C40	ZR	*	.00020<	.00130	.00042<	.00123	2.11<	15.05	.1
C42	MO	*	.00100<	.00230	.00028<	.00106	.28<	1.23	-.3
C48	CD	*	.00300<	.00840	.00252<	.00477	.84<	2.84	-.0
C50	SN	*	.00100<	.01190	.00131<	.00446	1.31<	16.24	.0
C56	BA	*	.00100<	.04940	.00242<	.01952	2.42<	*****	.0
C82	PB	*	.00610+-	.00190	.00187+-	.00242	.31+-	.41	-1.4
C201	OC	*	6.75600+-	.74560	7.65368+-	2.05536	1.13+-	.33	.4
C202	EC	*	3.05620+-	.39120	2.36461+-	1.69222	.77+-	.56	-.4
C203	SO4	*	2.62230+-	.33970	2.62230+-	.28354	1.00+-	.17	.0
C204	NO3	*	10.67640+-	.63040	10.67640+-	1.06936	1.00+-	.12	.0
C205	NH4	*	3.69220+-	.21370	3.69220+-	.38274	1.00+-	.12	.0
C219	K2	*	.15140+-	.01580	.13470+-	.18007	.89+-	1.19	-.1

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SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/25/99 CMB7 33889
SAMPLE DURATION 9 START HOUR 10 SIZE: ALL
R SQUARE .98 PERCENT MASS 92.7
CHI SQUARE .19 DF 24

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
64	RWBCOMTV	15.4846	3.6663	4.2235
105	AMMON	4.3395	.5269	8.2356
106	SULFATE	2.7699	.4892	5.6619
107	NITRATE	12.7648	1.4856	8.5922

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/25/99 CMB7 33889
SAMPLE DURATION 9 START HOUR 10 SIZE: ALL
R SQUARE .98 PERCENT MASS 92.7
CHI SQUARE .19 DF 24

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	38.14080+-	1.91900	35.35885+-	3.94437	.93+-	.11	-.6
C11	NA		.02300+-	.00850	.04717+-	.10689	2.05+-	4.71	.2
C12	MG		.00410<	.02680	.01505<	.02394	3.67<	24.70	.3
C13	AL		.03290+-	.00620	.02028+-	.02975	.62+-	.91	-.4
C14	SI		.12990+-	.04200	.06194+-	.11579	.48+-	.90	-.6
C15	P		.01210+-	.00320	.00299+-	.00471	.25+-	.39	-1.6
C16	S		.96740+-	.12533	.96659+-	.10259	1.00+-	.17	.0
C17	CL	*	.19600+-	.04310	.32787+-	.48868	1.67+-	2.52	.3
C19	K	*	.15030+-	.00850	.19627+-	.24802	1.31+-	1.65	.2
C20	CA	*	.02560+-	.00410	.06706+-	.09717	2.62+-	3.82	.4
C22	TI	*	.00370<	.02130	.00255<	.00706	.69<	4.41	-.1
C23	V	*	.00200<	.00900	.00063<	.00291	.32<	2.04	-.1
C24	CR	*	.00100<	.00220	.00022<	.00071	.22<	.86	-.3
C25	MN	*	.00090<	.00160	.00139<	.00220	1.55<	3.68	.2
C26	FE	*	.04300+-	.00610	.01990+-	.03619	.46+-	.84	-.6
C28	NI	*	.00100+-	.00100	.00203+-	.00829	2.03+-	8.53	.1
C29	CU		.00950+-	.00090	.00217+-	.00564	.23+-	.59	-1.3
C30	ZN		.01630+-	.00140	.01212+-	.01830	.74+-	1.12	-.2
C31	GA	*	.00010<	.00150	.00015<	.00060	1.55<	24.00	.0
C33	AS	*	.00050<	.00200	.00020<	.00070	.40<	2.13	-.1
C34	SE	*	.00010<	.00100	.00003<	.00038	.31<	4.92	-.1
C35	BR	*	.00520+-	.00080	.00159+-	.00278	.31+-	.54	-1.2
C37	RB	*	.00100+-	.00090	.00029+-	.00051	.29+-	.58	-.7
C38	SR	*	.00050<	.00090	.00053<	.00103	1.05<	2.80	.0
C39	Y	*	.00100<	.00110	.00003<	.00043	.03<	.43	-.8
C40	ZR	*	.00020<	.00130	.00045<	.00131	2.25<	15.99	.1
C42	MO	*	.00100<	.00240	.00029<	.00112	.29<	1.33	-.3
C48	CD	*	.00190<	.00910	.00268<	.00507	1.41<	7.26	.1
C50	SN	*	.00430<	.01310	.00139<	.00474	.32<	1.48	-.2
C56	BA	*	.00520<	.05350	.00257<	.02073	.49<	6.46	-.0
C82	PB	*	.00440+-	.00210	.00198+-	.00257	.45+-	.62	-.7
C201	OC	*	7.34240+-	.81310	8.12869+-	2.18292	1.11+-	.32	.3
C202	EC	*	3.19580+-	.41030	2.51136+-	1.79725	.79+-	.57	-.4
C203	SO4	*	2.90220+-	.37600	2.90220+-	.31151	1.00+-	.17	.0
C204	NO3	*	12.85240+-	.74420	12.85240+-	1.28581	1.00+-	.12	.0
C205	NH4	*	4.47450+-	.25790	4.47450+-	.45845	1.00+-	.12	.0
C219	K2	*	.10590+-	.01150	.14306+-	.19136	1.35+-	1.81	.2

SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/25/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	19	SIZE:	ALL
R SQUARE	.92	PERCENT MASS	94.4		
CHI SQUARE	.87	DF	24		

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
64	RWBCOMTV	15.7687	3.8489	4.0969
105	AMMON	3.7632	.4644	8.1041
106	SULFATE	2.3375	.3073	7.6070
107	NITRATE	11.6209	1.3541	8.5822

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/25/99 CMB7 33889

SAMPLE DURATION	5	START HOUR	19	SIZE:	ALL
R SQUARE	.92	PERCENT MASS	94.4		
CHI SQUARE	.87	DF	24		

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	35.48770+-	1.81490	33.49031+-	4.03580	.94+-	.12	-.5
C11	NA		.02180+-	.01490	.04803+-	.10885	2.20+-	5.22	.2
C12	MG		.02610<	.03870	.01533<	.02438	.59<	1.28	-.2
C13	AL		.03250+-	.00970	.02066+-	.03029	.64+-	.95	-.4
C14	SI		.13750+-	.07430	.06307+-	.11792	.46+-	.89	-.5
C15	P		.00510<	.01070	.00304<	.00480	.60<	1.57	-.2
C16	S		.82403+-	.04430	.82322+-	.09025	1.00+-	.12	.0
C17	CL	*	.16560+-	.05530	.33389+-	.49764	2.02+-	3.08	.3
C19	K	*	.14010+-	.00950	.19987+-	.25257	1.43+-	1.81	.2
C20	CA	*	.02400+-	.00690	.06829+-	.09895	2.85+-	4.20	.4
C22	TI	*	.13340+-	.02970	.00260+-	.00719	.02+-	.05	-4.3
C23	V	*	.00410<	.01690	.00065<	.00297	.16<	.97	-.2
C24	CR	*	.00100<	.00390	.00022<	.00072	.22<	1.12	-.2
C25	MN	*	.00100<	.00290	.00142<	.00224	1.42<	4.69	.1
C26	FE	*	.05660+-	.01060	.02026+-	.03685	.36+-	.65	-.9
C28	NI	*	.00040<	.00180	.00207<	.00844	5.16<	31.38	.2
C29	CU		.01250+-	.00150	.00221+-	.00574	.18+-	.46	-1.7
C30	ZN		.01990+-	.00230	.01235+-	.01864	.62+-	.94	-.4
C31	GA	*	.00010<	.00280	.00016<	.00061	1.58<	44.57	.0
C33	AS	*	.00100<	.00340	.00020<	.00070	.20<	.99	-.2
C34	SE	*	.00010<	.00180	.00003<	.00038	.32<	6.85	-.0
C35	BR	*	.00420+-	.00120	.00162+-	.00283	.39+-	.68	-.8
C37	RB	*	.00020<	.00150	.00030<	.00052	1.50<	11.53	.1
C38	SR	*	.00040<	.00170	.00054<	.00105	1.34<	6.27	.1
C39	Y	*	.00100<	.00200	.00003<	.00043	.03<	.43	-.5
C40	ZR	*	.00100<	.00240	.00046<	.00133	.46<	1.72	-.2
C42	MO	*	.00010<	.00440	.00030<	.00114	3.00<	*****	.0
C48	CD	*	.00650<	.01630	.00273<	.00516	.42<	1.32	-.2
C50	SN	*	.00100<	.02340	.00142<	.00483	1.42<	33.56	.0
C56	BA	*	.00330<	.09640	.00262<	.02111	.79<	24.04	.0
C82	PB	*	.00300<	.00490	.00202<	.00262	.67<	1.40	-.2
C201	OC	*	7.96270+-	.95470	8.27784+-	2.22298	1.04+-	.31	.1
C202	EC	*	2.57130+-	.33440	2.55744+-	1.83022	.99+-	.72	.0
C203	SO4	*	2.47210+-	.13290	2.47210+-	.27514	1.00+-	.12	.0
C204	NO3	*	11.71000+-	.67690	11.71000+-	1.17271	1.00+-	.12	.0
C205	NH4	*	3.90060+-	.22420	3.90060+-	.40533	1.00+-	.12	.0
C219	K2	*	.09680+-	.01190	.14569+-	.19476	1.51+-	2.02	.3

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SOURCE CONTRIBUTION ESTIMATES -  SITE: BFS5         DATE: 1/4/91      CMB7 33889
 SAMPLE DURATION        24      START HOUR        0         SIZE:    ALL
        R SQUARE       .96    PERCENT MASS      94.4
      CHI SQUARE       .49              DF        21

   SOURCE
      * TYPE     SCE(UG/M3)    STD ERR      TSTAT
 ---------------------------------------------
 2      TVURD       11.9146     1.6683     7.1419
 28     HDDNFR4      6.5984     2.1906     3.0121
 48     PBFT          .4657      .2182     2.1340
 70     WDSTVIF     43.6224     8.8477     4.9304
 105    AMMON       18.9661     3.2914     5.7623
 106    SULFATE     19.7972     3.4465     5.7442
 107    NITRATE     39.2276     6.7997     5.7690
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 SPECIES CONCENTRATIONS -  SITE: BFS5         DATE: 1/4/91      CMB7 33889
 SAMPLE DURATION        24      START HOUR        0         SIZE:    ALL
        R SQUARE       .96    PERCENT MASS      94.4
      CHI SQUARE       .49              DF        21
 SPECIES-------I---MEAS------------------CALC-------------RATIO C/M----RATIO R/U
 C1     TOTAL  T 149.00100+-  2.98002 140.59190+- 11.50835    .94+-  .08     -.7
 C11    NA          .00100+-   .00100    .03520+-   .07140  35.20+-79.60      .5
 C12    MG          .00100+-   .00100    .01117+-   .06735  11.17+-68.27      .2
 C13    AL          .32567<    .36937    .47023<    .23299   1.44<  1.79      .3
 C14    SI          .00100+-   .00100   2.07256+-   .92159  *****+-*****     2.2
 C15    P           .00100<    .13238    .00198<    .07915   1.98< *****      .0
 C16    S          1.19329+-   .19838   6.65482+-   .65996   5.58+- 1.08     7.9
 C17    CL       *  .03188+-   .00968    .05204+-   .00849   1.63+-  .56     1.6
 C19    K        *  .22498+-   .04435    .28180+-   .08084   1.25+-  .44      .6
 C20    CA       *  .16283+-   .15499    .28230+-   .04676   1.73+- 1.67      .7
 C22    TI       *  .04257+-   .00503    .04500+-   .04429   1.06+- 1.05      .1
 C23    V        *  .00207+-   .00098    .00048+-   .04381    .23+-21.16     -.0
 C24    CR       *  .00086+-   .00069    .00380+-   .04364   4.43+-50.98      .1
 C25    MN       *  .02753+-   .00319    .01758+-   .00353    .64+-  .15    -2.1
 C26    FE       *  .42138+-   .04886    .44141+-   .05550   1.05+-  .18      .3
 C28    NI       *  .00197+-   .00066    .00172+-   .04363    .87+-22.15      .0
 C29    CU          .01473+-   .00176    .00088+-   .04363    .06+- 2.96     -.3
 C30    ZN          .04668+-   .00544    .01676+-   .00851    .36+-  .19    -3.0
 C31    GA       *  .00010<    .00045    .00017<    .04412   1.67< *****      .0
 C33    AS       *  .00100<    .00333    .00011<    .04371    .11< 43.72     -.0
 C34    SE       *  .00010<    .00063    .00003<    .04363    .31< *****      .0
 C35    BR       *  .01864+-   .00222    .02865+-   .04475   1.54+- 2.41      .2
 C37    RB       *  .00088<    .00096    .00138<    .04363   1.57< 49.44      .0
 C38    SR       *  .00323+-   .00125    .00349+-   .04363   1.08+-13.50      .0
 C39    Y        *  .00100<    .00124    .00040<    .04412    .40< 44.13     -.0
 C40    ZR       *  .00100<    .00270    .00181<    .04363   1.81< 43.90      .0
 C42    MO       *  .00100<    .00764    .00010<    .04413    .10< 44.13     -.0
 C48    CD       *  .00100<    .00671    .00063<    .00698    .63<  8.17     -.0
 C50    SN       *  .00100<    .00982    .00123<    .04422   1.23< 45.83      .0
 C56    BA       *  .00100<    .04879    .01364<    .01502  13.64< *****      .2
 C82    PB       *  .05494+-   .00666    .10892+-   .05788   1.98+- 1.08      .9
 C201   OC       * 26.47607+-  2.96011  21.61664+-  3.90586    .82+-  .17    -1.0
 C202   EC       *  8.57676+-   .95891   8.59693+-  1.14094   1.00+-  .17      .0
 C203   SO4      * 19.95028+-  2.82140  19.95028+-  1.97995   1.00+-  .17      .0
 C204   NO3      * 39.27906+-  5.55490  39.27905+-  3.92279   1.00+-  .17      .0
 C205   NH4      * 19.01802+-  2.68955  19.01802+-  1.89786   1.00+-  .17      .0
 C219   K2       *  .12430+-   .01758    .08163+-   .05364    .66+-  .44     -.8
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SOURCE CONTRIBUTION ESTIMATES - SITE: BMVS DATE: 1/4/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .91 PERCENT MASS 87.9
CHI SQUARE 1.08 DF 21

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
2	TVURD	5.8782	1.0579	5.5565
24	HDSCE	7.7901	2.8133	2.7690
49	PBSS	.3819	.1834	2.0816
70	WDSTVIF	34.5834	8.3299	4.1517
105	AMMON	20.9825	3.6389	5.7661
106	SULFATE	22.2659	3.8948	5.7169
107	NITRATE	41.7585	7.2362	5.7708

SPECIES CONCENTRATIONS - SITE: BMVS DATE: 1/4/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .91 PERCENT MASS 87.9
CHI SQUARE 1.08 DF 21

SPECIES		I	MEAS		CALC		RATIO C/M	RATIO R/U
C1	TOTAL	T	152.00100+-	3.04002	133.64050+-	11.28174	.88+- .08	-1.6
C11	NA		.00100+-	.00100	.00944+-	.47439	9.44+-*****	.0
C12	MG		.00100+-	.00100	.00577+-	.01027	5.77+-11.78	.5
C13	AL		.16231<	.36417	.24380<	.11034	1.50< 3.44	.2
C14	SI		.00100+-	.00100	1.03491+-	.45353	*****+-*****	2.3
C15	P		.00100<	.13184	.00754<	.03463	7.54< *****	.0
C16	S		1.19403+-	.19801	7.47550+-	.74215	6.26+- 1.21	8.2
C17	CL	*	.01113+-	.00835	.04004+-	.00603	3.60+- 2.75	2.8
C19	K	*	.14241+-	.03465	.15618+-	.02389	1.10+- .32	.3
C20	CA	*	.01331<	.14988	.14409<	.02303	10.83< *****	.9
C22	TI	*	.01978+-	.00259	.02292+-	.03482	1.16+- 1.77	.1
C23	V	*	.00351+-	.00093	.00051+-	.03464	.14+- 9.88	-.1
C24	CR	*	.00035<	.00066	.00274<	.03459	7.73< 98.77	.1
C25	MN	*	.01978+-	.00235	.01195+-	.00365	.60+- .20	-1.8
C26	FE	*	.21953+-	.02648	.21775+-	.03851	.99+- .21	-.0
C28	NI	*	.00035<	.00060	.00118<	.03459	3.34< 97.87	.0
C29	CU		.01835+-	.00215	.00079+-	.03459	.04+- 1.89	-.5
C30	ZN		.03140+-	.00376	.01306+-	.00333	.42+- .12	-3.7
C31	GA	*	.00010<	.00045	.00014<	.03459	1.44< *****	.0
C33	AS	*	.00298+-	.00237	.00053+-	.03463	.18+-11.63	-.1
C34	SE	*	.00010<	.00063	.00049<	.03459	4.86< *****	.0
C35	BR	*	.01312+-	.00165	.03356+-	.03484	2.56+- 2.67	.6
C37	RB	*	.00068<	.00096	.00066<	.03459	.97< 50.59	.0
C38	SR	*	.00038<	.00116	.00171<	.03459	4.52< 92.32	.0
C39	Y	*	.00100<	.00124	.00020<	.03460	.20< 34.60	-.0
C40	ZR	*	.00100<	.00265	.00089<	.03469	.89< 34.77	.0
C42	MO	*	.00152<	.00771	.00005<	.03463	.03< 22.83	-.0
C48	CD	*	.00100<	.00672	.00044<	.02917	.44< 29.32	-.0
C50	SN	*	.00100<	.00983	.00061<	.03490	.61< 35.40	-.0
C56	BA	*	.01828<	.04947	.00699<	.01985	.38< 1.50	-.2
C82	PB	*	.03358+-	.00454	.06440+-	.03591	1.92+- 1.10	.9
C201	OC	*	26.99005+-	3.01758	19.08519+-	3.08521	.71+- .14	-1.8
C202	EC	*	6.52985+-	.72978	6.63498+-	.85019	1.02+- .17	.1
C203	SO4	*	22.57463+-	3.19253	22.57462+-	2.23052	1.00+- .17	.0
C204	NO3	*	41.79105+-	5.91015	41.79105+-	4.17646	1.00+- .17	.0
C205	NH4	*	21.01990+-	2.97266	21.01990+-	2.09945	1.00+- .17	.0
C219	K2	*	.21828+-	.03087	.05922+-	.05565	.27+- .26	-2.5

SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 1/7/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .96 PERCENT MASS 102.5
CHI SQUARE .54 DF 22

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
2	TVURD	7.9596	1.0778	7.3849
49	PBSS	.2063	.0341	6.0467
71	RWBCOMST	55.2193	8.2703	6.6768
105	AMMON	27.1692	4.7219	5.7539
106	SULFATE	26.9653	4.7260	5.7057
107	NITRATE	59.8269	10.3808	5.7632

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 1/7/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .96 PERCENT MASS 102.5
CHI SQUARE .54 DF 22

SPECIES		I	MEAS		CALC		RATIO C/M	RATIO R/U
C1	TOTAL	T	173.00100+-	3.46002	177.34660+-	14.78396	1.03+- .09	.3
C11	NA		.00100+-	.00100	.03270+-	.04674	32.70+-57.05	.7
C12	MG		.00100+-	.00100	.00798+-	.01604	7.98+-17.92	.4
C13	AL		.20883<	.38652	.31294<	.15171	1.50< 2.87	.3
C14	SI		.00100+-	.00100	1.39582+-	.61435	*****+-*****	2.3
C15	P		.00100<	.13549	.00157<	.05525	1.57< *****	.0
C16	S		1.57240+-	.26091	9.05264+-	.89891	5.76+- 1.11	8.0
C17	CL	*	.10317+-	.01793	.06311+-	.01657	.61+- .19	-1.6
C19	K	*	.20261+-	.04168	.31355+-	.07647	1.55+- .49	1.3
C20	CA	*	.11187<	.15330	.18990<	.03197	1.70< 2.34	.5
C22	TI	*	.03033+-	.00370	.03059+-	.03008	1.01+- 1.00	.0
C23	V	*	.00219+-	.00091	.00029+-	.05527	.13+-25.19	-.0
C24	CR	*	.00100+-	.00068	.00254+-	.05523	2.54+-55.25	.0
C25	MN	*	.02063+-	.00244	.01144+-	.00294	.55+- .16	-2.4
C26	FE	*	.28216+-	.03338	.30145+-	.02826	1.07+- .16	.4
C28	NI	*	.00060+-	.00058	.00113+-	.05522	1.87+-91.60	.0
C29	CU		.01255+-	.00152	.00221+-	.00393	.18+- .31	-2.5
C30	ZN		.04058+-	.00478	.01661+-	.01879	.41+- .47	-1.2
C31	GA	*	.00010<	.00045	.00010<	.05522	.99< *****	.0
C33	AS	*	.00030<	.00262	.00085<	.00352	2.80< 26.72	.1
C34	SE	*	.00010<	.00063	.00001<	.05522	.11< *****	.0
C35	BR	*	.01523+-	.00187	.01802+-	.00290	1.18+- .24	.8
C37	RB	*	.00096<	.00096	.00090<	.05522	.94< 57.71	.0
C38	SR	*	.00162+-	.00120	.00232+-	.05522	1.44+-34.19	.0
C39	Y	*	.00100<	.00124	.00027<	.05522	.27< 55.23	-.0
C40	ZR	*	.00219<	.00281	.00121<	.05522	.55< 25.18	-.0
C42	MO	*	.00100<	.00758	.00062<	.00613	.62< 7.71	-.0
C48	CD	*	.00100<	.00671	.00013<	.05524	.13< 55.25	-.0
C50	SN	*	.00100<	.00982	.00082<	.05526	.82< 55.84	.0
C56	BA	*	.00852<	.04923	.01350<	.09478	1.59< 14.42	.0
C82	PB	*	.04002+-	.00514	.03299+-	.00794	.82+- .22	-.7
C201	OC	*	25.48167+-	2.84894	26.48649+-	3.71154	1.04+- .19	.2
C202	EC	*	5.92915+-	.66346	5.95490+-	2.47509	1.00+- .43	.0
C203	SO4	*	27.28403+-	3.85854	27.28403+-	2.72943	1.00+- .17	.0
C204	NO3	*	59.97514+-	8.48177	59.97514+-	5.98683	1.00+- .17	.0
C205	NH4	*	27.28403+-	3.85854	27.28403+-	2.72256	1.00+- .17	.0
C219	K2	*	.31137+-	.04403	.43866+-	.70488	1.41+- 2.27	.2

SOURCE CONTRIBUTION ESTIMATES - SITE: BMVS DATE: 1/7/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .95 PERCENT MASS 91.0
CHI SQUARE .57 DF 22

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
2	TVURD	4.4437	.6777	6.5567
49	PBSS	.1309	.0239	5.4855
71	RWBCOMST	40.3187	6.0153	6.7027
105	AMMON	25.6915	4.4609	5.7593
106	SULFATE	24.3094	4.2475	5.7232
107	NITRATE	54.4149	9.4379	5.7656

SPECIES CONCENTRATIONS - SITE: BMVS DATE: 1/7/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .95 PERCENT MASS 91.0
CHI SQUARE .57 DF 22

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	164.00100+-	3.28002	149.30910+-	12.72960	.91+-	.08	-1.1
C11	NA		.00100+-	.00100	.02224+-	.03358	22.24+-	40.27	.6
C12	MG		.00100+-	.00100	.00465+-	.01093	4.65+-	11.87	.3
C13	AL		.10781<	.37438	.17498<	.08565	1.62<	5.69	.2
C14	SI		.00100+-	.00100	.78147+-	.34308	*****+-	*****	2.3
C15	P		.00100<	.13383	.00094<	.04034	.94<	*****	.0
C16	S		1.23296+-	.20483	8.14824+-	.81032	6.61+-	1.28	8.3
C17	CL	*	.02652+-	.00925	.04473+-	.01194	1.69+-	.74	1.2
C19	K	*	.13879+-	.03423	.20250+-	.05396	1.46+-	.53	1.0
C20	CA	*	.06877<	.15133	.10718<	.01817	1.56<	3.44	.3
C22	TI	*	.01791+-	.00241	.01717+-	.02189	.96+-	1.23	-.0
C23	V	*	.00171+-	.00082	.00017+-	.04034	.10+-	23.59	-.0
C24	CR	*	.00058<	.00068	.00142<	.04032	2.46<	70.07	.0
C25	MN	*	.01115+-	.00144	.00667+-	.00207	.60+-	.20	-1.8
C26	FE	*	.16295+-	.02025	.16972+-	.01761	1.04+-	.17	.3
C28	NI	*	.00103+-	.00058	.00063+-	.04032	.61+-	39.19	.0
C29	CU		.02652+-	.00304	.00153+-	.00290	.06+-	.11	-6.0
C30	ZN		.03494+-	.00415	.01185+-	.01372	.34+-	.39	-1.6
C31	GA	*	.00010<	.00045	.00006<	.04032	.60<	*****	.0
C33	AS	*	.00302+-	.00196	.00059+-	.00257	.20+-	.86	-.7
C34	SE	*	.00066+-	.00064	.00001+-	.04032	.01+-	61.38	-.0
C35	BR	*	.01041+-	.00138	.01148+-	.00199	1.10+-	.24	.4
C37	RB	*	.00028<	.00093	.00050<	.04032	1.80<	*****	.0
C38	SR	*	.00188+-	.00120	.00130+-	.04032	.69+-	21.41	-.0
C39	Y	*	.00100<	.00123	.00015<	.04032	.15<	40.32	-.0
C40	ZR	*	.00100<	.00271	.00067<	.04032	.67<	40.37	.0
C42	MO	*	.00100<	.00762	.00044<	.00449	.44<	5.60	-.1
C48	CD	*	.00100<	.00669	.00007<	.04033	.07<	40.33	-.0
C50	SN	*	.00100<	.00985	.00046<	.04034	.46<	40.59	-.0
C56	BA	*	.00100<	.04839	.00839<	.06910	8.39<	*****	.1
C82	PB	*	.02299+-	.00360	.02097+-	.00551	.91+-	.28	-.3
C201	OC	*	19.08302+-	2.13355	19.26780+-	2.70959	1.01+-	.18	.1
C202	EC	*	9.47955+-	1.06040	4.34706+-	1.80715	.46+-	.20	-2.4
C203	SO4	*	24.53532+-	3.46982	24.53532+-	2.45043	1.00+-	.17	.0
C204	NO3	*	54.52292+-	7.71071	54.52292+-	5.44392	1.00+-	.17	.0
C205	NH4	*	25.77447+-	3.64506	25.77448+-	2.57233	1.00+-	.17	.0
C219	K2	*	.29492+-	.04171	.31826+-	.51615	1.08+-	1.76	.0

SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 2/1/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .97 PERCENT MASS 82.5
CHI SQUARE .51 DF 20

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
1	TVPRD	62.9869	6.4797	9.7206
5	PRDTV	7.0132	2.9829	2.3512
28	HDDNFR4	6.8687	3.3831	2.0303
49	PBSS	.2560	.0476	5.3747
64	RWBCOMTV	15.8347	6.8024	2.3278
105	AMMON	1.3128	.3129	4.1956
106	SULFATE	2.7624	.5425	5.0922
107	NITRATE	6.9213	1.2229	5.6597

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 2/1/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .97 PERCENT MASS 82.5
CHI SQUARE .51 DF 20

SPECIES		I	MEAS		CALC		RATIO C/M	RATIO R/U
C1	TOTAL	T	126.00100+-	2.52002	103.95600+-	6.62973	.83+- .06	-3.1
C11	NA		.00100+-	.00100	.08485+-	.13740	84.85+-*****	.6
C12	MG		.00100+-	.00100	.27521+-	.10568	*****+-*****	2.6
C13	AL		3.77723+-	.84795	2.28119+-	1.16215	.60+- .34	-1.0
C14	SI		.00100+-	.00100	9.82639+-	4.70120	*****+-*****	2.1
C15	P		.00100<	.12446	.00962<	.07145	9.62< *****	.1
C16	S		.70317+-	.11786	1.34583+-	.20525	1.91+- .43	2.7
C17	CL	*	.63472+-	.09566	.42729+-	.50271	.67+- .80	-.4
C19	K	*	1.96640+-	.29949	1.38046+-	.35403	.70+- .21	-1.3
C20	CA	*	2.05974+-	.36231	2.27259+-	.31420	1.10+- .25	.4
C22	TI	*	.25389+-	.02856	.25394+-	.04615	1.00+- .21	.0
C23	V	*	.01413+-	.00325	.00551+-	.02369	.39+- 1.68	-.4
C24	CR	*	.00439+-	.00101	.00811+-	.00469	1.85+- 1.15	.8
C25	MN	*	.05949+-	.00675	.05331+-	.00522	.90+- .13	-.7
C26	FE	*	2.10952+-	.23740	2.37190+-	.16269	1.12+- .15	.9
C28	NI	*	.00033<	.00064	.00769<	.00862	23.32< 51.97	.9
C29	CU		.03099+-	.00354	.00709+-	.00603	.23+- .20	-3.4
C30	ZN		.10952+-	.01247	.05753+-	.02067	.53+- .20	-2.2
C31	GA	*	.00010<	.00050	.00068<	.00777	6.78< 84.90	.1
C33	AS	*	.00243<	.00430	.00163<	.00458	.67< 2.23	-.1
C34	SE	*	.00010<	.00064	.00021<	.00198	2.06< 23.73	.1
C35	BR	*	.01786+-	.00215	.02396+-	.00443	1.34+- .30	1.2
C37	RB	*	.00840+-	.00137	.00745+-	.00180	.89+- .26	-.4
C38	SR	*	.02856+-	.00354	.02530+-	.00396	.89+- .18	-.6
C39	Y	*	.00100<	.00126	.00183<	.00733	1.83< 7.69	.1
C40	ZR	*	.00622+-	.00300	.00891+-	.00315	1.43+- .86	.6
C42	MO	*	.00100<	.00765	.00058<	.00893	.58< 9.99	-.0
C48	CD	*	.00840+-	.00702	.00362+-	.01960	.43+- 2.36	-.2
C50	SN	*	.00100<	.00996	.00359<	.02725	3.59< 44.91	.1
C56	BA	*	.07592+-	.05153	.07046+-	.10890	.93+- 1.57	-.0
C82	PB	*	.07405+-	.00868	.05450+-	.00842	.74+- .14	-1.6
C201	OC	*	19.22838+-	2.15119	20.48250+-	2.72721	1.07+- .19	.4
C202	EC	*	9.14748+-	1.02272	8.99705+-	1.99646	.98+- .24	-.1
C203	SO4	*	3.05538+-	.43210	3.05538+-	.32074	1.00+- .18	.0
C204	NO3	*	7.03174+-	.99444	7.03174+-	.71102	1.00+- .17	.0
C205	NH4	*	1.53080+-	.21649	1.53080+-	.21854	1.00+- .20	.0
C219	K2	*	.28065+-	.03969	.20294+-	.19992	.72+- .72	-.4

22

SOURCE CONTRIBUTION ESTIMATES - SITE: BFS5 DATE: 12/4/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .98 PERCENT MASS 85.4
CHI SQUARE .21 DF 22

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
2	TVURD	21.5101	2.7266	7.8889
48	PBFT	.1819	.0660	2.7566
64	RWBCOMTV	39.3620	9.9861	3.9417
105	AMMON	6.8131	1.2818	5.3152
106	SULFATE	9.1713	1.6811	5.4555
107	NITRATE	14.3574	2.5456	5.6402

SPECIES CONCENTRATIONS - SITE: BFS5 DATE: 12/4/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .98 PERCENT MASS 85.4
CHI SQUARE .21 DF 22

SPECIES		I	MEAS		CALC		RATIO C/M		RATIO R/U
C1	TOTAL	T	107.00100+-	2.14002	91.39572+-	9.99701	.85+-	.09	-1.5
C11	NA		.00100+-	.00100	.15259+-	.27207	*****+-	*****	.6
C12	MG		.00100+-	.00100	.05684+-	.06554	56.84+-	86.76	.9
C13	AL		1.07664+-	.38460	.89262+-	.41040	.83+-	.48	-.3
C14	SI		.00100+-	.00100	3.89205+-	1.68543	*****+-	*****	2.3
C15	P		.00100<	.12044	.01007<	.01287	10.07<	*****	.1
C16	S		1.00973+-	.16764	3.19449+-	.32634	3.16+-	.62	6.0
C17	CL	*	.18248+-	.02879	.85486+-	1.24228	4.68+-	6.85	.5
C19	K	*	.56995+-	.09309	.91445+-	.63582	1.60+-	1.15	.5
C20	CA	*	.72993+-	.20220	.66539+-	.26094	.91+-	.44	-.2
C22	TI	*	.08577+-	.00982	.08766+-	.02080	1.02+-	.27	.1
C23	V	*	.00548+-	.00142	.00239+-	.00959	.44+-	1.75	-.3
C24	CR	*	.00482+-	.00213	.00738+-	.00225	1.53+-	.82	.8
C25	MN	*	.03400+-	.00393	.02819+-	.00598	.83+-	.20	-.8
C26	FE	*	.82117+-	.09527	.84307+-	.11084	1.03+-	.18	.1
C28	NI	*	.00272+-	.00129	.00815+-	.02106	3.00+-	7.88	.3
C29	CU		.05937+-	.00670	.00692+-	.01433	.12+-	.24	-3.3
C30	ZN		.06874+-	.00807	.03520+-	.04653	.51+-	.68	-.7
C31	GA	*	.00010<	.00047	.00053<	.00170	5.35<	30.24	.2
C33	AS	*	.00195<	.00294	.00060<	.00223	.31<	1.23	-.4
C34	SE	*	.00010<	.00062	.00010<	.00101	1.05<	12.02	.0
C35	BR	*	.01581+-	.00192	.01513+-	.00806	.96+-	.52	-.1
C37	RB	*	.00188+-	.00095	.00319+-	.00133	1.70+-	1.11	.8
C38	SR	*	.01034+-	.00167	.00761+-	.00268	.74+-	.28	-.9
C39	Y	*	.00100<	.00119	.00080<	.00118	.80<	1.52	-.1
C40	ZR	*	.00398+-	.00257	.00440+-	.00336	1.11+-	1.11	.1
C42	MO	*	.00119<	.00742	.00092<	.00309	.78<	5.51	-.0
C48	CD	*	.00100<	.00657	.00716<	.01340	7.16<	48.93	.4
C50	SN	*	.00119<	.00949	.00576<	.01318	4.86<	40.41	.3
C56	BA	*	.00100<	.04957	.02959<	.05714	29.59<	*****	.4
C82	PB	*	.04696+-	.00582	.04931+-	.01626	1.05+-	.37	.1
C201	OC	*	22.62774+-	2.52986	21.68724+-	5.55566	.96+-	.27	-.2
C202	EC	*	8.45499+-	.94611	6.41789+-	4.56927	.76+-	.55	-.4
C203	SO4	*	9.61071+-	1.35916	9.61071+-	.98620	1.00+-	.17	.0
C204	NO3	*	14.59854+-	2.06454	14.59854+-	1.48856	1.00+-	.17	.0
C205	NH4	*	7.17762+-	1.01507	7.17762+-	.77821	1.00+-	.18	.0
C219	K2	*	.19830+-	.02804	.39560+-	.48563	1.99+-	2.47	.4

23

SOURCE CONTRIBUTION ESTIMATES - SITE: BMVS DATE: 12/16/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .96 PERCENT MASS 83.1
CHI SQUARE .30 DF 22

SOURCE *	TYPE	SCE(UG/M3)	STD ERR	TSTAT
2	TVURD	15.0041	2.6728	5.6136
48	PBFT	.1367	.0577	2.3692
64	RWBCOMTV	45.6320	11.3939	4.0050
105	AMMON	4.3487	.9175	4.7395
106	SULFATE	6.8299	1.3095	5.2155
107	NITRATE	9.5345	1.7442	5.4664

SPECIES CONCENTRATIONS - SITE: BMVS DATE: 12/16/91 CMB7 33889
SAMPLE DURATION 24 START HOUR 0 SIZE: ALL
R SQUARE .96 PERCENT MASS 83.1
CHI SQUARE .30 DF 22

SPECIES		I	MEAS	CALC	RATIO C/M	RATIO R/U
C1	TOTAL	T	98.01000+- 1.96020	81.48585+- 10.97889	.83+- .11	-1.5
C11	NA		.00100+- .00100	.16218+- .31516	*****+-*****	.5
C12	MG		.00100+- .00100	.05732+- .07256	57.32+-92.47	.8
C13	AL		.71691+- .33736	.64650+- .29471	.90+- .59	-.2
C14	SI		.00100+- .00100	2.78762+- 1.20683	*****+-*****	2.3
C15	P		.00100< .11826	.01055< .01426	10.55< *****	.1
C16	S		.87010+- .14485	2.42325+- .26318	2.79+- .55	5.2
C17	CL	*	.18750+- .02947	.98117+- 1.44012	5.23+- 7.72	.6
C19	K	*	.48591+- .08161	.86824+- .73314	1.79+- 1.54	.5
C20	CA	*	.71691+- .20131	.54286+- .29230	.76+- .46	-.5
C22	TI	*	.06556+- .00758	.06415+- .02206	.98+- .35	-.1
C23	V	*	.00149+- .00113	.00241+- .00957	1.61+- 6.52	.1
C24	CR	*	.00100< .00184	.00540< .00227	5.40< 10.19	1.5
C25	MN	*	.02941+- .00343	.02139+- .00665	.73+- .24	-1.1
C26	FE	*	.59253+- .06993	.61145+- .11504	1.03+- .23	.1
C28	NI	*	.00065< .00120	.00807< .02442	12.41< 43.97	.3
C29	CU		.02341+- .00271	.00737+- .01661	.31+- .71	-1.0
C30	ZN		.05637+- .00671	.03881+- .05394	.69+- .96	-.3
C31	GA	*	.00010< .00045	.00056< .00182	5.57< 30.86	.2
C33	AS	*	.00244< .00250	.00066< .00225	.27< .96	-.5
C34	SE	*	.00010< .00059	.00011< .00109	1.10< 12.74	.0
C35	BR	*	.01330+- .00166	.01302+- .00868	.98+- .66	-.0
C37	RB	*	.00189+- .00094	.00257+- .00149	1.36+- 1.04	.4
C38	SR	*	.00809+- .00150	.00593+- .00304	.73+- .40	-.6
C39	Y	*	.00100< .00120	.00059< .00126	.59< 1.44	-.2
C40	ZR	*	.00177< .00252	.00360< .00386	2.04< 3.64	.4
C42	MO	*	.00100< .00717	.00099< .00340	.99< 7.85	.0
C48	CD	*	.00100< .00649	.00814< .01514	8.14< 55.01	.4
C50	SN	*	.01379+- .00960	.00565+- .01445	.41+- 1.09	-.5
C56	BA	*	.00100< .04945	.02366< .06301	23.66< *****	.3
C82	PB	*	.03744+- .00487	.03901+- .01351	1.04+- .39	.1
C201	OC	*	24.14216+- 2.69917	24.67184+- 6.43572	1.02+- .29	.1
C202	EC	*	11.27451+- 1.25998	7.42577+- 5.29664	.66+- .48	-.7
C203	SO4	*	7.29167+- 1.03120	7.29167+- .80186	1.00+- .18	.0
C204	NO3	*	9.80392+- 1.38648	9.80392+- 1.05668	1.00+- .18	.0
C205	NH4	*	4.76103+- .67331	4.76103+- .61568	1.00+- .19	.0
C219	K2	*	.29167+- .04125	.44387+- .56264	1.52+- 1.94	.3

Appendix E

Rollback Analysis For PM_{10} Concentrations
in Ada County, Idaho,
Yayi Dong, IDEQ

ROLLBACK ANALYSIS FOR PM_{10} CONCENTRATIONS IN ADA COUNTY, IDAHO

September 23, 2002

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Part of this document is adopted from the report of Desert Research Institute "Analyzing Speciated Ambient PM_{10} Concentrations and Emissions in Ada and Canyon Counties, Idaho", 1998

ABSTRACT

Exceedances of the 24-hour PM_{10} EPA National Ambient Air Quality Standard (NAAQS) were observed in Boise, Idaho in 1988, 1989, and 1991. This was sufficient cause for the EPA to designate Ada County a moderate PM_{10} non-attainment area. Although the annual average PM_{10} concentrations have never exceeded the NAAQS, the annual average PM_{10} concentrations for future years must be estimated, as emissions changes would affect air quality in the area. The Idaho Department of Environmental Quality (DEQ) will submit a PM_{10} Maintenance Plan by September 30, 2002. This rollback modeling will support the PM_{10} Maintenance Plan.

The Desert Research Institute originally developed this PM10 speciated linear rollback model in 1998 for Treasure Valley PM_{10} analysis. The model uses chemically resolved background and urban ambient PM_{10} concentrations, emissions inventories, and chemical source profiles to assess the impacts of major air pollution sources on PM_{10} levels.

All available source profiles were collected during winters, when there were higher percentages of secondary aerosols, and organic and elemental PM_{10} carbon. The annual average PM_{10} is expected to contain a higher percentage of geologic material and less secondary aerosols and carbons than the winter PM_{10} profile. The base year is 1999, when the annual average PM_{10} was 29.3 $\mu g/m^3$. The predicted annual average PM_{10} concentrations for the years 2010, 2015, 2020 and 2030 are 34, 38 (using 2020 on road emissions), 38 and 42 $\mu g/m^3$, respectively.

The study showed that it is unlikely an exceedance of standard will occur in the foreseeable future. The study showed that it is unlikely for exceedance of standard will occur in the foreseeable future.

An additional episodic analysis by rollback was performed to reconcile the dispersion modeling. The results are attached in the appendix.

1. INTRODUCTION AND OBJECTIVES

The Boise, Idaho metropolitan area in Idaho has experienced exceedances of the existing 24-hour PM_{10} NAAQS in the past, but not recently. DEQ believes that past emissions reduction efforts have improved air quality, and that additional improvements will result from currently planned emissions reductions. While the data indicate no exceedances of current annual PM_{10} NAAQS, there is concern about future PM_{10} annual average concentrations in this fast growing area.

Several studies have been undertaken over the past ten years to characterize emissions and ambient concentrations in the region. These studies were mostly focused on the 24-hour concentrations in winter seasons. Since the long-term average concentrations reflect general emissions levels, the annual average study will support the current State Implementation Plan (SIP) revisions, which are to guide network design activities related to the new $PM_{2.5}$ and PM_{10} standards (U.S. EPA, 1997a). In addition, the study will identify knowledge gaps for prioritizing future work.

This "Rollback Analysis for PM_{10} concentrations in Ada County, Idaho" project intends to predict the PM_{10} annual average levels for future years using existing information, identify the major sources of PM_{10}, and recommend control strategies.

An additional episodic analysis by rollback was performed to reconcile the dispersion modeling. The results are attached in the appendix.

2. BACKGROUND OF ROLLBACK MODELING

Linear rollback (Barth, 1970; Cass and McRae, 1981, 1983) is the model most commonly used to develop control strategy, though it is not often identified as such. Rollback assumes that pollutant concentrations in excess of background are proportional to aggregate emissions rates. Reducing excessive concentrations of a pollutant to levels below an established standard requires emissions reductions that are proportionally equal to the relative amount by which the standard is exceeded.

Suspended particulate matter, especially $PM_{2.5}$ and PM_{10} size fractions that are regulated by NAAQS, are composed of several major chemical components, notably geological material, organic carbon, elemental carbon, sulfate, and nitrate. Most of the first three materials are directly emitted by sources (primary particles). Geologic material includes suspended soil dust from vehicle traffic, bare ground, and agricultural and construction activities. Vegetative (residential wood burning and open burning) and fossil fuel combustion are sources of organic carbon and elemental carbon. Diesel fuel combustion is a large source of elemental carbon. Ammonium nitrate and ammonium sulfate form primarily from emissions of ammonia, sulfur dioxide, and oxides of nitrogen gases (secondary particles). Chemical plants and animal husbandry are the major sources of ammonia. Fossil fuel combustion (from vehicles, trains, planes, power plants, residential and commercial heating, industry)is the main source of sulfur dioxide and oxides of nitrogen . The “speciated” linear rollback model is applied to each of these chemical components, rather than to total mass concentration, in order to obtain an approximation of which emissions reduction strategies might result in lower ambient concentrations of each of these species.

Linear rollback does not consider the effects of meteorological transport between source and receptor, or of differences in gas-to-particle conversion for different precursor emitters. It is most valid for spatial and temporal averages of ambient concentrations that represent the entire airshed containing urban-scale sources. The effect of transport from distant sources located outside the airshed is compensated by subtracting background concentrations, which are measured nearby but outside the airshed, from ambient levels, prior to determining needed emissions reductions.

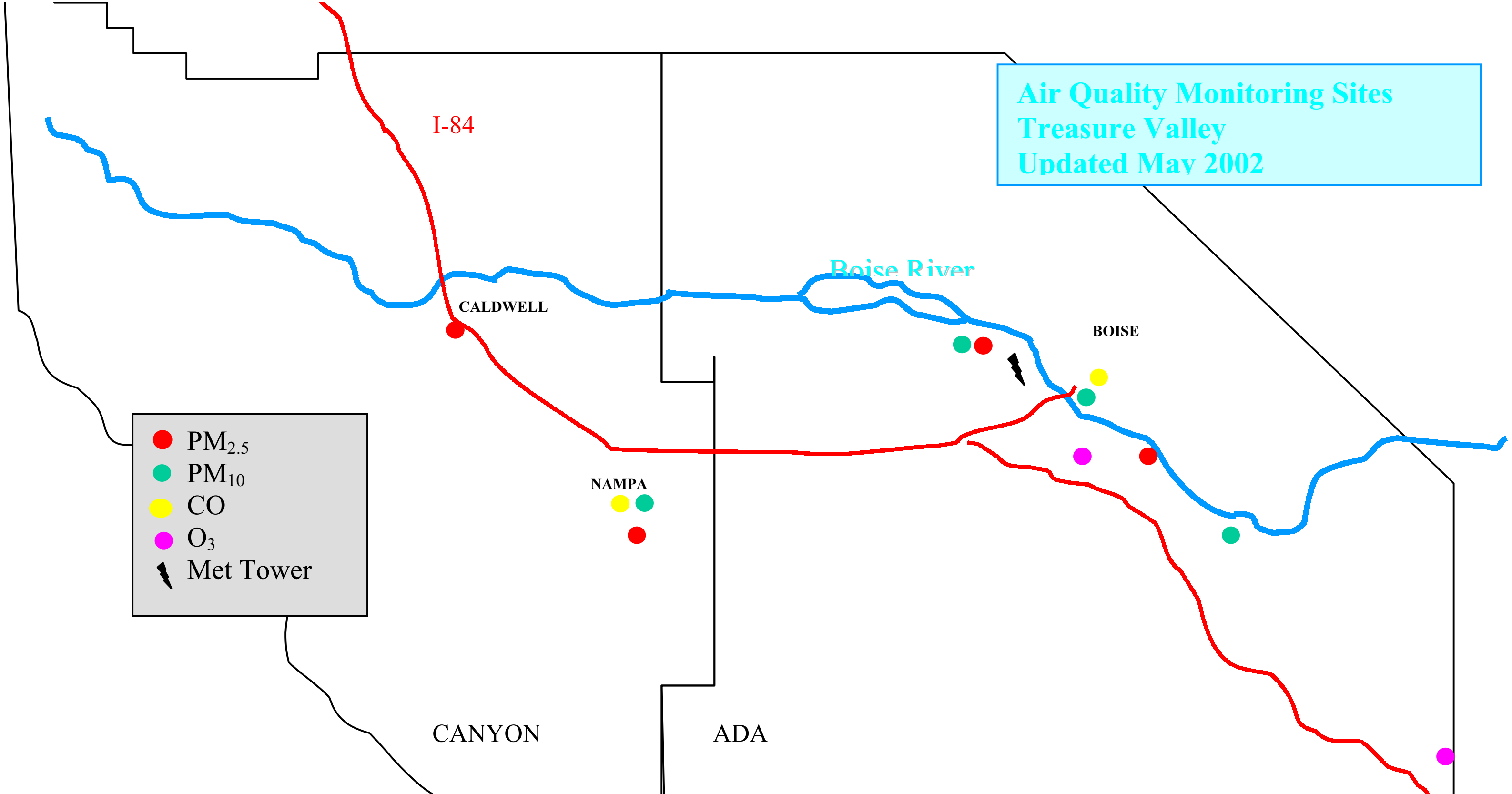
Linear rollback also assumes, for secondary particles such as ammonium nitrate and ammonium sulfate, that one of the precursors limits particle formation (Watson, et al., 1994). In many cases, there is sufficient ammonia in the atmosphere that reductions in sulfur dioxide and oxide of nitrogen precursors are needed to reduce secondary sulfate and nitrate particle concentrations. Ammonia levels in the Ada and Canyon Counties are not known, however. More recent secondary aerosol study showed that VOC might be the controlling factor in the secondary aerosol formation. The degree to which sulfur dioxide and oxides of nitrogen contribute to suspended particles depends on many variables besides emissions, including temperature, relative humidity, and the presence or absence of other gases and liquid water (clouds or fog). Effects of precursor emissions reductions may only be detected on long-term average sulfate and nitrate concentrations rather than on individual samples. Since the secondary aerosol formation occurs mainly in winter episodes, it was not considered in this modeling. However, general discussions were made for the influence of weather conditions.

3. SITE DESCRIPTION AND MONITORING DATA

3.1. Site Description

Ada and Canyon Counties are located in southwestern Idaho. Together, the two counties cover over 1600 square miles. The terrain is primarily high desert. Mountains border the eastern and northeastern edge of Ada County. The Snake River runs along the southwestern edges of both counties. Since two counties are in the same airshed, two counties were modeled as one domain.

Figure 3-1 is a map of the Treasure Valley and shows the locations of the air monitoring stations in both Ada and Canyon Counties.



Pollutant	City	Location	Monitors
PM10	Nampa	Nampa Fire Station (1st Street South)	1 filter, 1 instantaneous
	Boise	Fire Station #5 (16th & Front)	1 filter, 1 instantaneous
	Boise	Le Bois School (SE Boise, on Grand Forest)	1 filter
	Boise	Mt View School (Near Cole & Ustick)	1 filter
PM2.5	Boise	Mt View School (Near Cole & Ustick)	1 filter, 1 instantaneous
	Boise	White Pine School (near Broadway & Federal)	1 filter
	Nampa	NNC (near Amity & 12th)	1 filter, speciation monitor,1 instantan
	Caldwell	Syringa School (Near Montana & Linden)	1 filter
CO	Nampa	Nampa Library (11th Ave & 2nd St South)	Continuous Gas Analyzer
	Boise	Eastman Parking Garage (9th & Idaho)	Continuous Gas Analyzer
O_3	Boise	Whitney School, (Overland & Owyhee)	Continuous Gas Analyzer
	Background (East of Boise)	Simco and Tilli Road	Continuous Gas Analyzer

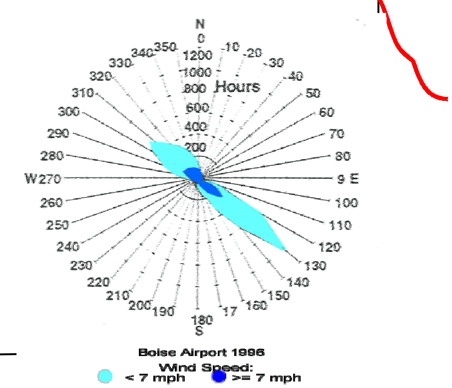


Figure 3-1 Site map of Treasure Valley showing Ada and Canyon Counties, major cities, and PM_{10} monitoring locations.

During winter months, high pressure over the region with light winds, subsidence aloft, and radiation cooling at the ground contribute to the formation of shallow inversions. Persistent wintertime stagnation episodes allow PM_{10} concentrations to increase. In summer and fall, concentrations of PM_{10} can become elevated but have not exceeded the 24-hour NAAQS since routine measurements began in 1986. The high PM_{10} events during summer and fall are primarily caused by windblown dust or forest fires.

Control strategies have been enacted to reduce PM_{10} levels in the valley. These measures include the following:

- an air quality advisory program
- tax incentives to encourage the replacement of older wood stoves with EPA-certified wood stoves
- wintertime road sweeping practices
- federal mobile emissions reductions.

3.2. Monitoring data

The PM_{10} concentrations measured in Treasure Valley are summarized in Table 3-1. The annual means are shown in Figure 3-2. The annual average PM_{10} concentrations decreased from 1994 to 1998, and then increased during1999 and 2000. The trend is similar for all monitoring sites, apparently because of meteorological conditions. Figure 3-3 shows the average concentrations for different seasons. The values in the figures are arithmetic means and are not weighted. Since the sampling frequencies are different from site to site, depending on the severity of PM_{10} scenarios or equipment problems, the arithmetic mean is not equal to the real average. The seasons are defined as: spring, February through April; summer, May through July; fall, August through October; winter, November through January. These definitions are based roughly on the character of seasonal variations of PM_{10} concentrations and compositions in the Treasure Valley.

The chart in Figure 3-3 does not include data from the Cloverdale site, because this site was assigned as a background site. Although the Cloverdale site is no longer used because of local dust scenarios, the data from this site showed an interesting phenomenon: the concentrations during summer and fall seasons are comparable to the average of the other sites, but the concentrations measured at this site during winter and spring seasons are much lower than the concentrations measured at other sites. During summer and fall, the main PM_{10} emissions are geologic materials for typical days, with smoke being the main source of PM_{10} during fires or burning events. Since the atmosphere is usually well mixed during summer and fall, the concentration levels are fairly uniform through the valley during those seasons. During winter and early spring, higher PM_{10} concentrations occur during stagnation periods, when the atmosphere is not well mixed so the PM_{10} levels vary more from site to site. Activity near the Cloverdale site declines during winter and spring, so the emissions levels are much lower.

For all sites, the highest average concentrations occur in the fall, and the lowest levels occur during spring and winter. While the highest 24-hour concentrations usually occur during winter, the winter average is the second lowest overall. The data indicate that the higher average PM_{10} levels occurring during fall and summer make the largest contributions to the annual average.

Table 3-1. Ambient PM_{10} Concentrations in Treasure Valley

Treasure Valley Air Quality Summary for PM_{10} (Standard Conditions), 1994-2000												
	24- Hour Values				# Exceedances		Annual					
# Obs	1st Max	2nd Max	3rd Max	4th Max	Actual	Estimated	Mean	Year	City	County	Monitor ID	Comments
45	55	54	53	46	0	0	N/a	1998	Liberty	Ada Co	160010003 - 1	Terminated
60	76	73	64	61	0	0	30.1	1997	Liberty	Ada Co	160010003 - 1	
61	77	70	64	57	0	0	28.1	1996	Liberty	Ada Co	160010003 - 1	
60	111	49	48	48	0	0	29.1	1995	Liberty	Ada Co	160010003 - 1	
58	123	77	73	62	0	0	33.4	1994	Liberty	Ada Co	160010003 - 1	
356	129	96	81	81	0	0	29.0	2000	BFS#5	Ada Co	160010009 - 3	TEOM
61	92	88	73	68	0	0	33.7	2000	BFS#5	Ada Co	160010009 - 1	
113	123	77	69	67	0	0	29.3	1999	BFS#5	Ada Co	160010009 - 1	
360	108	95	89	86	0	0	30.5	1999	BFS#5	Ada Co	160010009 - 3	TEOM
94	62	62	60	59	0	0	26.4	1998	BFS#5	Ada Co	160010009 - 1	
120	73	65	62	57	0	0	31.6	1997	BFS#5	Ada Co	160010009 - 1	
129	98	90	85	81	0	0	32.6	1996	BFS#5	Ada Co	160010009 - 1	
120	103	95	93	89	0	0	35.2	1995	BFS#5	Ada Co	160010009 - 1	
130	131	102	100	96	0	0	39.1	1994	BFS#5	Ada Co	160010009 - 1	
59	57	53	45	44	0	0	23.0	2000	Mt View	Ada Co	160010011 - 1	
60	95	60	50	49	0	0	22.3	1999	Mt View	Ada Co	160010011 - 1	
44	49	41	33	30	0	0	16.8	1998	Mt View	Ada Co	160010011 - 1	
120	71	66	58	49	0	0	24.1	1997	Mt View	Ada Co	160010011 - 1	
123	73	62	60	56	0	0	23.5	1996	Mt View	Ada Co	160010011 - 1	
117	107	77	73	67	0	0	24.7	1995	Mt View	Ada Co	160010011 - 1	
118	106	91	86	77	0	0	31.5	1994	Mt View	Ada Co	160010011 - 1	
16	29	27	22	21	0	0	N/A	2000	Meridian	Ada Co	160010013 - 1	Terminated
59	90	72	67	65	0	0	25.1	1999	Meridian	Ada Co	160010013 - 1	
61	68	52	48	45	0	0	20.3	1998	Meridian	Ada Co	160010013 - 1	
59	69	54	44	42	0	0	26.3	1997	Meridian	Ada Co	160010013 - 1	

Treasure Valley Air Quality Summary for PM_{10} (Standard Conditions), 1994-2000 (continued)												
	24- Hour Values				# Exceedances		Annual					
60	100	62	57	54	0	0	28.5	1996	Meridian	Ada Co	160010013 - 1	
48	82	82	68	63	0	0	32.1	1994	Meridian	Ada Co	160010013 - 1	
60	71	70	61	57	0	0	29.6	1995	Meridian	Ada Co	160010013 - 1	
30	41	37	32	26	0	0	N?A	1998	Cloverdale	Ada Co	160010015 - 1	Terminated
59	161K	91	84	79	0	0	25.2	1997	Cloverdale	Ada Co	160010015 - 1	
60	113	82	75	56	0	0	20.7	1996	Cloverdale	Ada Co	160010015 - 1	
26	73	67	66	51	0	0	28.7	1995	Cloverdale	Ada Co	160010015 - 1	
59	54	49	48	46	0	0	18.6	2000	Les Bois	Ada Co	160010018 - 1	
39	80	59	50	47	0	0	22.2	1999	Les Bois	Ada Co	160010018 - 1	
338	83	82	79	78	0	0	26.3	2000	Nampa	Canyon Co	160270002 - 2	TEOM
58	83	62	62	57	0	0	29.8	2000	Nampa	Canyon Co	160270002 - 1	
58	103	101	82	70	0	0	34.1	1999	Nampa	Canyon Co	160270002 - 1	
58	78	67	59	52	0	0	25.1	1998	Nampa	Canyon Co	160270002 - 1	
58	80	63	62	57	0	0	34.6	1997	Nampa	Canyon Co	160270002 - 1	
57	131	74	69	66	0	0	35.7	1996	Nampa	Canyon Co	160270002 - 1	
59	81	79	78	76	0	0	39.5	1995	Nampa	Canyon Co	160270002 - 1	
59	113	110	84	81	0	0	40.6	1994	Nampa	Canyon Co	160270002 - 1	

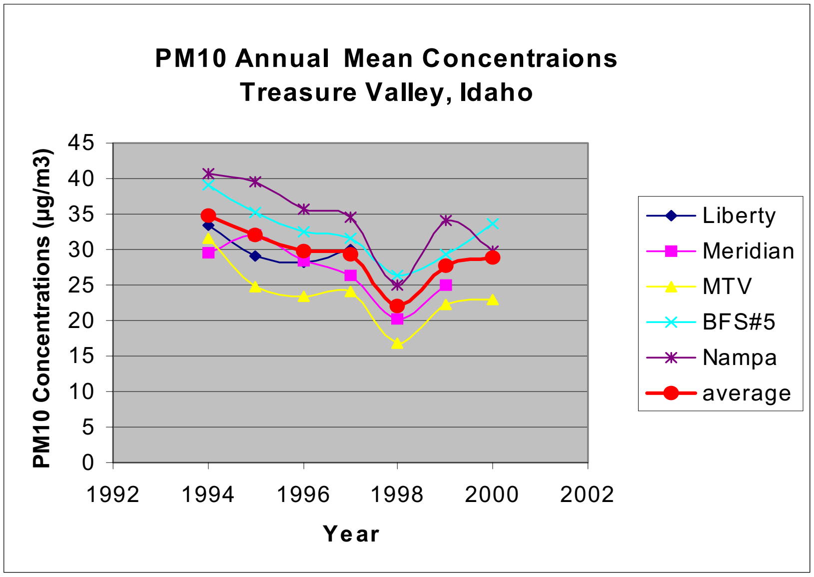


Figure 3-2 PM_{10} annual mean concentration measured at sites in Treasure Valley.

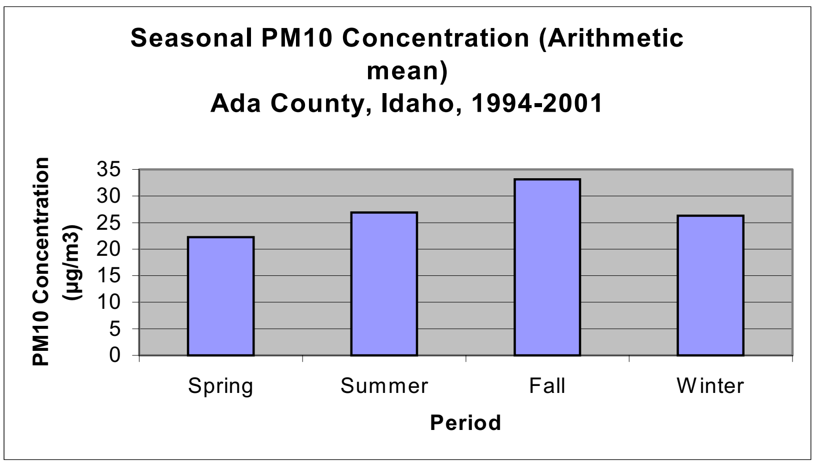


Figure 3-3 PM_{10} average concentrations of all monitoring sites (except Cloverdale) during different seasons.

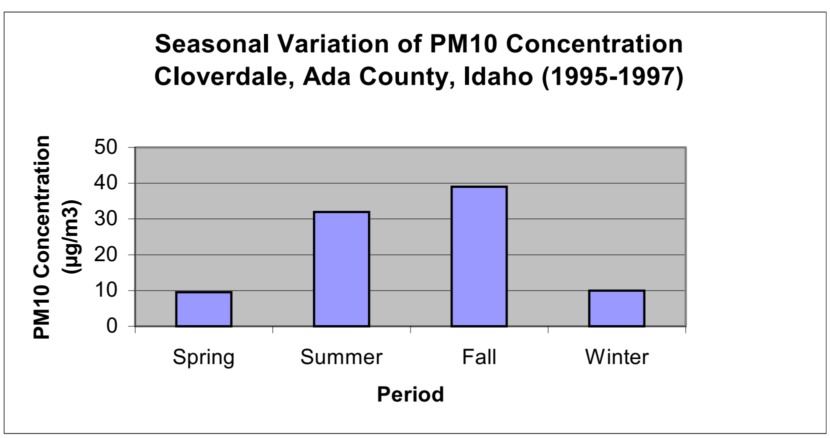


Figure 3-4 PM_{10} average concentrations at Cloverdale site during different seasons.

4. INPUT DATA FOR SPECIATED ROLLBACK MODELING

For this study, speciated rollback modeling implies that the aerosol is made up of five major components: geologic material, organic mass, elemental carbon, ammonium sulfate, and ammonium nitrate. Projected increases in ambient PM_{10} for future years are evaluated on a component-by-component basis. Speciated rollback modeling requires two types of data sets: ambient concentrations and emissions inventories. Speciated ambient concentration data are available from previous PM_{10} studies conducted in Ada and Canyon Counties. Ambient background concentrations are estimated from IMPROVE samplers operated at the Jarbidge Wilderness Area in northern Nevada. Emissions estimates of PM_{10}, NO_x, SO_x and NH_3 (these are the only four used in the rollback modeling, and only PM_{10} inventory was used for annual analysis) for base year 1999 and the future years were generated by Environ International Corporation for both Ada and Canyon Counties. The PM_{10} emissions are converted into speciated PM_{10} emissions using source profiles. A description of each of the data sets used in this analysis follows.

4.1. Urban PM_{10} Concentrations

Ambient PM_{10} is primarily composed of five major fractions: geologic material, organic mass, elemental carbon, particulate sulfur, and particulate nitrate. The geologic material component is estimated by summing the elements predominantly associated with soil plus oxygen for the normal oxides (Al_2O_3, SiO_2, CaO, FeO, Fe_2O_3, and TiO_2) plus a correction for other compounds such as MgO, Na_2O, water, and carbonate (Sisler, et al., 1996). The final equation for the geologic component of aerosol mass is:

$$[\text{Geologic}] = 2.20\,[\text{Al}] + 2.49\,[\text{Si}] + 1.63\,[\text{Ca}] + 2.42\,[\text{Fe}] + 1.94\,[\text{Ti}] \qquad (1)$$

where all concentrations have units of mass per volume unit of air ($\mu g/m^3$). The components of these factors were confirmed in a comparison of local re-suspended soils and ambient aerosols in the western United States (Cahill, et al., 1981 and Pitchford, et al., 1981).

Based on the assumption that aerosol organic mass is 70% carbon (Watson, et al., 1988), the organic mass component can be calculated from the measured organic carbon as:

$$[\text{Organic Mass}] = 1.4\,[\text{OC}] \qquad (2)$$

where [OC] is organic carbon.

Elemental carbon exists by itself in the aerosol such that:

$$[\text{Elemental Carbon}] = [\text{EC}] \qquad (3)$$

In the rural areas of the western United States, particulate sulfate and particulate nitrate are usually fully neutralized with ammonium. The equations for the sulfur and nitrate components of the aerosol are:

$$[\text{Ammonium Sulfate}] = 1.375\,[SO_4] \qquad (4)$$

$$[\text{Ammonium Nitrate}] = 1.29\,[NO_3] \qquad (5)$$

The combination of the five individual components is frequently referred to as the reconstructed aerosol mass.

This analysis uses speciated PM_{10} measurements from the Liberty Fire Station (LFBC), Nampa Fire Station (FSNA), Meridian (FIME), Mountain View Elementary School (MVBC), and Fire Station #5 (FSBC) sites in Ada and Canyon Counties (Figure 4-1). These sites are part of the EPA Aerometric Information Retrieval System (AIRS) network and are supported by DEQ. Select PM_{10} samples from these sites have been analyzed for chemical speciation since January 28, 1988. Most of these samples were selected for analysis based on high PM_{10} concentrations. These analyses took place at the Environmental Analysis Facility at Desert Research Institute in Reno, Nevada. Analyses included x-ray Fluorescence (XRF) and Atomic Absorption (AA) for elemental composition, Ion Chromatography (IC) for sulfate and nitrate, Colorometric Analysis (CA) for ammonium, and Thermal Optical Reflectance (TOR) for elemental and organic carbon.

Table 4-1 lists PM_{10} monitoring sites in Ada and Canyon Counties and the dates on which speciated PM_{10} data were collected during the winter (November through February).

Table 4-1 PM_{10} monitoring sites in Ada and Canyon Counties

EPA Site Number	Site Name	Location	Operated Since	Number of Speciated Samples	Dates of Speciated Samples
16-001-0003	Liberty Fire Station (LFBC)	Fairview and Liberty, Boise City	2/27/1989	3	12/22/94, 1/3/95, and 8/13/96
16-001-0009	Fire Station #5 (FSBC)	16th and Grove Street, Boise City	1/1/1986	21	1/28/88, 2/9/89, 12/20/89, 1/4/91, 1/7/91, 2/1/91, 12/24/91, 12/16/91, 6/11/92, 10/21/92, 10/27/92, 2/4/93, 8/31/94, 12/22/94, 1/3/95, 8/13/96, 11/5/96, 11/11/96, 11/23/96, 1/4/97, 1/10/97, 1/16/97, 1/28/97, and 8/20/97
16-001-0011	Mountain View Elementary School (MVBC)	3500 Carbarton Lane, Boise City	12/5/1985	9	1/28/88, 2/9/89, 1/4/91, 1/7/91, 2/1/91, 12/16/91, 12/24/91, 10/21/92, 12/22/94, 1/3/95, and 8/13/96
16-001-0013	Meridian (FIME)	1516 1st Street, Meridian	1/31/1992	5	10/21/92, 10/27/92, 1/3/95, 8/13/96, and 8/20/97
16-027-0002	Nampa Fire Station (FSNA)	923 1st Street, Nampa	7/16/1993	5	9/23/94, 12/22/94, 1/3/95, 8/13/96, and 8/20/97

The majority of the samples analyzed are quartz fiber that is partially composed of silicon. The XRF analysis cannot resolve the aerosol geologic component of silicon on these types of filters. Moreover, the silicon in the filter can interfere with the resolution of aluminum during the chemical analysis. Silicon and aluminum make up a significant fraction of the geologic component of the aerosol mass. In order to estimate the size of the geologic component, silicon and aluminum are assumed to be linearly proportional to iron. This assumption is validated by comparing iron to silicon for the seven Teflon filters analyzed with a dichotomous sampler at Fire Station #5 between November 5, 1996 and January 28, 1997 (Figure 4-1). Aluminum was resolved on 10 quartz filters (collected at MVBC and FSBC in January, February, and December of 1991), in addition to the seven Teflon filters. The left panel of the figure is the regression of aluminum with iron for the 10 quartz and seven Teflon filters.

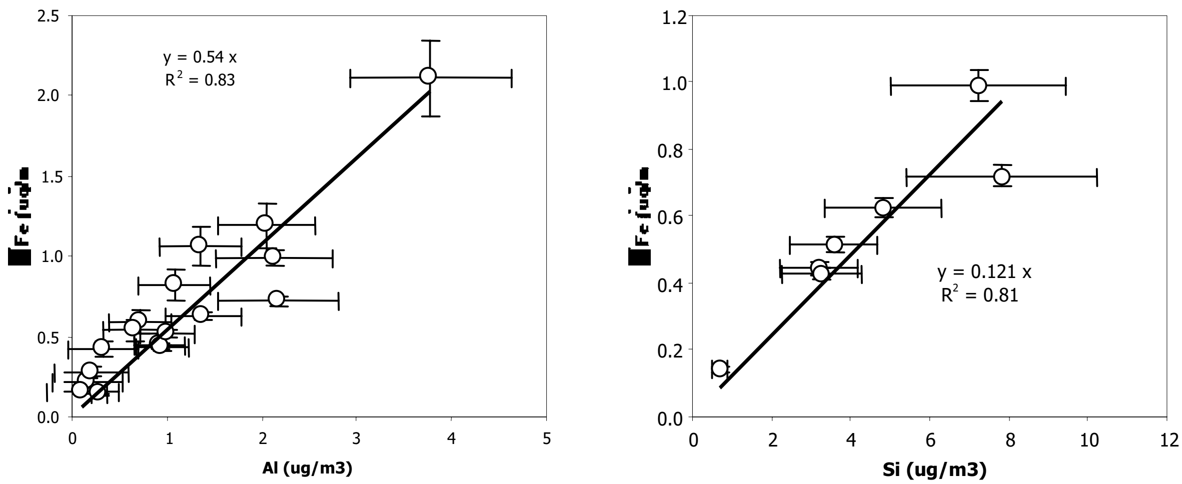


Figure 4-1 Comparison of aluminum (Al) and silicon (Si) aerosol concentrations with iron (Fe) for analysis of filters collected in Treasure Valley, Idaho.

Given that these relationships hold for the aerosol data collected on the remaining quartz filters, the aluminum and silicon concentrations for all filters are estimated using equations 6 and 7.

$$[Al] = 1.8 (\pm 0.1) [Fe] \quad (6)$$

$$[Si] = 8.0 (\pm 0.6) [Fe] \quad (7)$$

The fractional composition of wintertime PM_{10} in Boise is estimated using these approximations and equations 1 – 5.

The results are shown in Figure 4-2. The top panel of the figure shows the absolute contributions of geologic material, organic mass, elemental carbon, ammonium sulfate, and ammonium nitrate to the PM_{10}. The lower panel shows the relative contributions of these components. The composition of the white portion of each column is unknown and is calculated as the difference in PM_{10} measured by gravimetric analysis and the reconstructed aerosol mass. The first four letters of the sample name correspond to the sample location. The following numbers denote the date the sample was collected (mm/dd/yy). Of the samples shown in Figure 4-2, between 0 and 30% of the aerosol mass is unknown. Possible explanations for the unknown mass include evaporation of volatile aerosol from the filter between gravimetric and chemical analysis (i.e., ammonium nitrate and some organic mass), presence of water on the filter, and presence of atypical chemicals in the aerosol (i.e., ammonium phosphate or sea-salt).

Visual inspection of the lower panel of Figure 4-2 indicates that two types of aerosol profiles have been observed in the Treasure Valley: the stagnation profile and the high profile. On 1/28/88, 1/4/91, and 1/7/91, PM_{10} exceedances of the 24-hour NAAQS (150 $\mu g/m^3$) were observed at either Fire Station #5 or Mountain View Elementary School. The measurement on 2/9/89 at Fire Station #5 does not count as an exceedance because the concentration was 153 $\mu g/m^3$ which is not significantly higher than the standard (i.e. greater than 155 $\mu g/m^3$). The PM_{10} chemical profiles for these periods are consistent between sites and between days. The average of the eight PM_{10} concentrations measured on these days at Fire Station #5 and

Mountain View Elementary School was 154 μg/m[3]). All three episodes are characterized with low amounts of geologic and elemental carbon material. The meteorology during each of the three episodes was characterized by persistent deep stable layers, and air quality advisories were in effect. Under these stagnant conditions, concentrations of secondary aerosol precursors such as SO_x and NO_x accumulate are oxidized to form particulate sulfate and nitrate. For these eight samples, ammonium nitrate and ammonium sulfate averaged approximately 37% and 16% of the PM_{10}, respectively. The average profile of the aerosol collected from this period will be referred to as the Stagnation Profile.

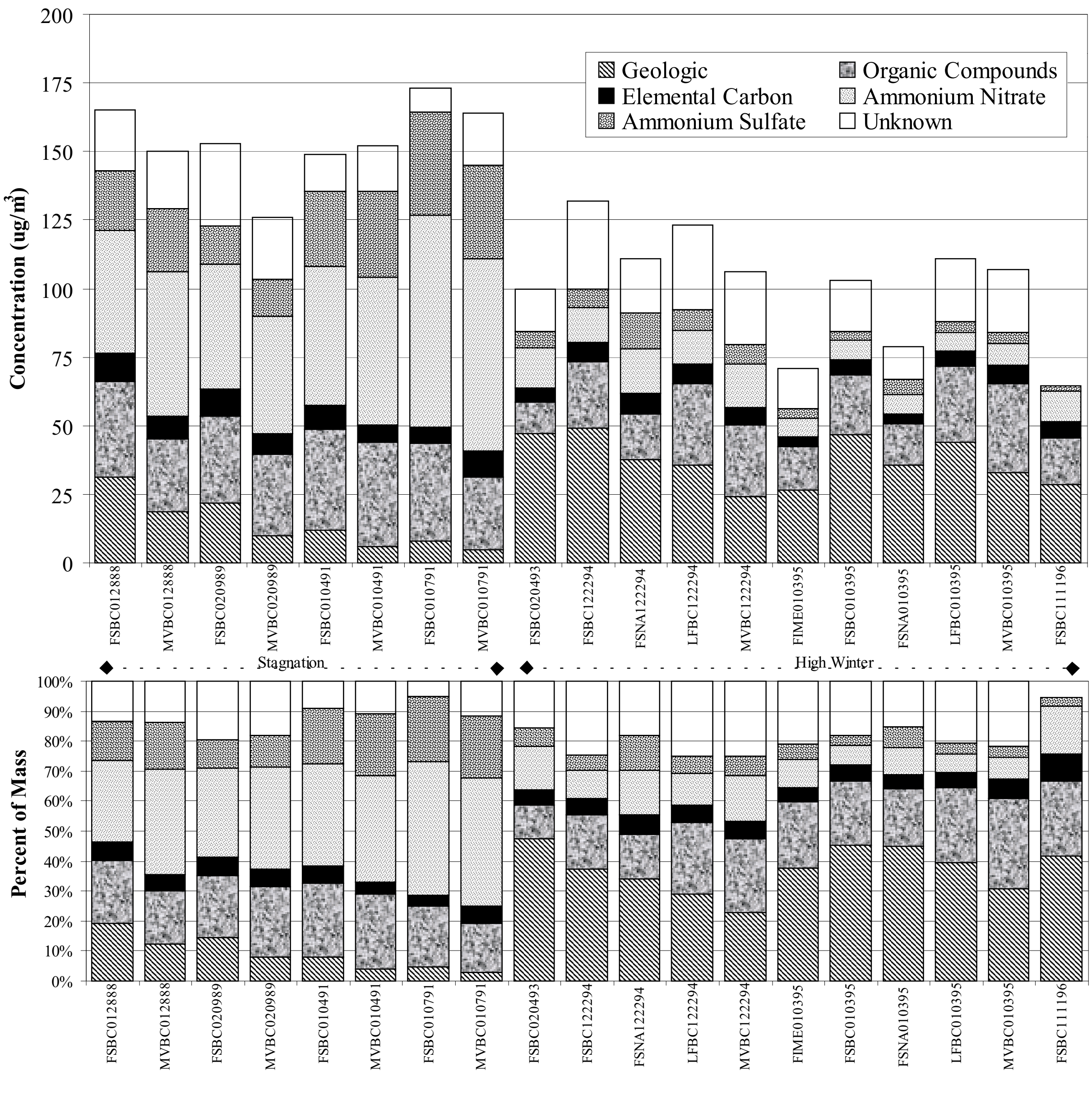


Figure 4-2 Wintertime absolute and relative speciated contributions to PM_{10} in Ada and Canyon Counties.

Eleven wintertime speciated samples collected between February 4, 1993 and November 11, 1996 are categorized as the High Profile. Although none of the samples exceeded the NAAQS, some of the highest PM_{10} measurements were taken during this period. The major components of the second profile are geologic material and organic compounds, which, on average, account for 36% and 22% of the PM_{10}, respectively. The average PM_{10} concentration associated with the second profile type is 100 $\mu g/m^3$, which is higher than any of the 90th percentile concentrations observed throughout the network.

The average aerosol profiles were calculated as the relative contributions of the average absolute component concentrations. Table 4-2 shows the average and standard deviation of the PM_{10} and chemical components used to calculate each profile. Figure 4-3 shows the relative composition of the two aerosol profile types.

Table 4-2 Average composition of Stagnation and High Aerosol Profiles. Uncertainties are the standard deviation of each component.

Aerosol Components	Stagnation Profile ($\mu g/m^3$)	High Profile ($\mu g/m^3$)
Geologic	14 ± 9	37 ± 9
Organic	32 ± 4	22 ± 7
Elemental Carbon	8 ± 2	6 ± 1
Ammonium Nitrate	55 ± 13	11 ± 4
Ammonium Sulfate	25 ± 9	6 ± 3
Unknown	19 ± 6	19 ± 10
Total	154 ± 14	100 ± 22

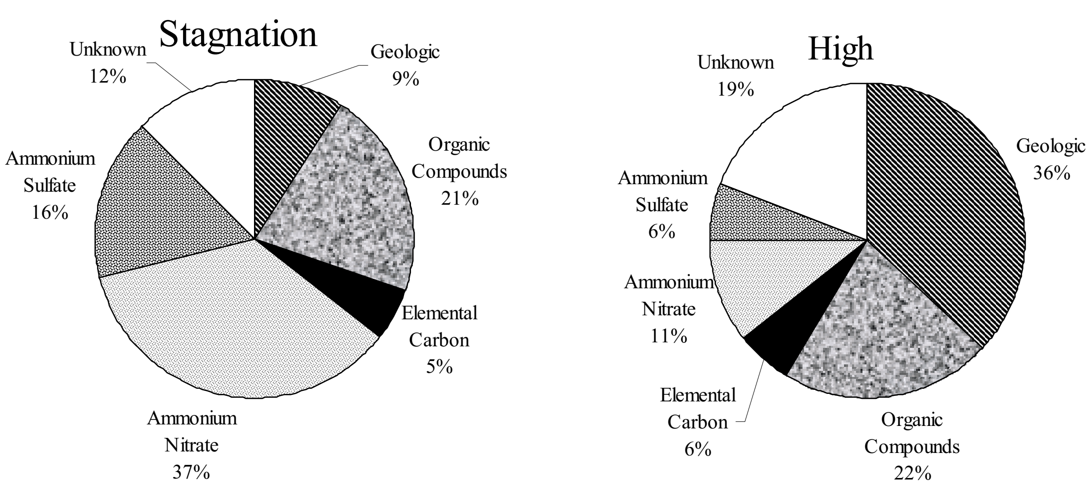


Figure 4-3 Stagnation and High aerosol profile types from Ada and Canyon Counties.

On an average day in the Treasure Valley, the dominating emission is road dust. Higher carbons were measured from the filters collected during forest fires, and much higher secondary aerosols were measured during stagnation winter events. These events are rare but carry a higher weight than the average concentrations. Considering all the variations from season to season, a high winter profile was chosen as an average annual profile.

Background PM_{10} Concentrations

Regional background concentrations must be known in order to estimate what fraction of the PM_{10} are due to emissions sources within the Treasure Valley. The rollback model assumes that the difference between the polluted PM_{10} levels and the background PM_{10} levels is proportional to the emissions within the airshed.

The IMPROVE network was established to monitor the visibility impairment in Class 1 areas throughout the United States (Sisler, et al., 1996). IMPROVE stations typically measure the chemical composition of $PM_{2.5}$ as well as light-absorbing properties of the aerosol. Some stations also feature a channel to measure PM_{10} concentrations, but chemical speciation is seldom done on these samples. The six IMPROVE stations closest to the Treasure Valley are: Bridger Wilderness Area, Wyoming; Craters of the Moon National Monument, Idaho; Jarbidge Wilderness Area, Nevada; Salmon Wilderness Area, Idaho; Sawtooth Wilderness Area, Idaho; and Yellowstone National Park, Wyoming. Jarbidge Wilderness Area is located approximately 200 miles south of Boise City, and is the closest IMPROVE site to the Treasure Valley with a PM_{10} channel. Both PM_{10} and $PM_{2.5}$ samples are collected at Jarbidge twice a week. Measurements from this site are used to estimate the background PM_{10} concentrations in the Treasure Valley.

PM_{10} and $PM_{2.5}$ mass and chemically speciated $PM_{2.5}$ data are available for the Jarbidge Wilderness Area beginning in 1988. Average annual PM_{10} mass and an estimate of the average concentration of each major PM_{10}component (geologic material, organic mass, elemental carbon, ammonium nitrate, and ammonium sulfate) were determined for the calendar year 1995 at Jarbidge (96 observations). Average winter concentrations were estimated using data for five winters (December-February), from 1991-1992 through 1995-1996. Five winters were used to obtain a reasonable total sample size (102 observations).

To permit comparison of the aerosol data between Jarbidge Wilderness Area and the Treasure Valley, air density corrections were made on the IMPROVE concentration data. For this calculation, average virtual temperatures and pressures were calculated using the lapse rate equation:

$$T = T_0 - (0.0065°C/m)\Delta z \qquad (8)$$

and the hydrostatic equation:

$$P = P_0 \exp\left(-\frac{g\Delta z}{RT}\right) \qquad (9)$$

Then, using the virtual temperature and pressure, density was calculated using the ideal gas law:

$$\rho = \frac{P}{RT} \qquad (10)$$

For estimating background concentrations at Boise, concentrations at Jarbidge (elevation 1,889 meters) were multiplied by 1.10 to account for increased air density at lower elevations in Boise.

Because $PM_{2.5}$ chemical speciation measurements and only total PM_{10} mass measurements were made at Jarbidge, some assumptions must be made to obtain estimated PM_{10} concentrations by major component. The following assumptions were made:

- All sulfate, nitrate, and elemental carbon are in the fine ($PM_{2.5}$) fraction.
- The same equations for the components were used as those described elsewhere in this report, except that fine geologic material was calculated as:

  $$[\text{Geologic}] = 3.05\,[\text{Si}] + 1.63\,[\text{Ca}] + 2.4\,[\text{Fe}] + 1.94\,[\text{Ti}] \qquad (11)$$

  A problem occurred with the detection of aluminum. To account for its contribution to fine geologic matter, the factor associated with silicon was increased. This correction is included in equation 11.
- Coarse material, defined as $PM_{10} - PM_{2.5}$, is 68% geologic, 17% organic, and 15% unexplained (probably mostly water).

The last assumption was based upon regression analysis between fine geologic material and coarse mass, and IMPROVE PM_{10} speciated measurements in the western United States. The regression analysis showed that for 1995, the fine geologic component accounted for over 70% of the variance in coarse mass and 85% of the total coarse mass. This implies that 85% of the coarse mass is associated with soil. The IMPROVE data for the other western sites, and local source profiles, suggest that of this 85%, about 4/5 is geologic and 1/5 is organic. The speciated background PM_{10} concentrations resulting from these calculations and adjusted for Boise air density are shown in Table 4-3. The uncertainty in the table represents the standard deviation over the 96 samples taken in 1995 and the 102 samples taken in winter. The winter averages and standard deviation are used as the background values for the rollback modeling.

Table 4-3 Background concentrations of major components of PM_{10} and $PM_{2.5}$ emissions at Jarbidge Wilderness.

Component	PM_{10} 1995 ($\mu g/m^3$)	PM_{10} Winter ($\mu g/m^3$)	$PM_{2.5}$ 1995 ($\mu g/m^3$)	$PM_{2.5}$ Winter ($\mu g/m^3$)
Geologic Material	4 ± 4	2 ± 3	0.6 ± 0.7	0.2 ± 0.6
Ammonium Sulfate	0.5 ± 0.3	0.4 ± 0.3	0.5 ± 0.3	0.4 ± 0.3
Ammonium Nitrate	0.1 ± 0.2	0.1 ± 0.6	0.1 ± 0.2	0.1 ± 0.6
Organic Mass	1.4 ± 1.2	0.9 ± 0.8	0.8 ± 0.9	0.5 ± 0.8
Elemental Carbon	0.3 ± 0.2	0.1 ± 0.2	0.3 ± 0.2	0.1 ± 0.2
PM	7 ± 6	5 ± 4	2.4 ± 1.8	1.5 ± 1.5

4.2. Ada and Canyon Counties Emissions Inventory

A comprehensive emissions inventory for Ada and Canyon Counties was assembled by Environ International Corporation for the base year 1999. Emissions were projected for the years 2010, 2015, and 2020 using estimates of activity, population, and economic growth. The inventory classified all sources into four categories: area, industrial, on-road mobile, and non-road mobile. Emissions of primary PM_{10}, NO_x, SO_x, and NH_3 were estimated for all sources within these categories.

For this emissions inventory, the 1999 base year was based on actual emissions estimates. Projected year industrial emissions inventories were calculated using only the maximum potential emissions and permitted emissions methods. This was done to comply with the EPA's required estimation methods for projected emissions inventories. The results of the average annual emissions inventory for base year 1995, using the actual industrial emissions estimate, are summarized in **Table 4-4**.

Table 4-4 Annual average emissions inventory for Ada and Canyon Counties (base year 1999). Emissions estimates units are tons/year.

Source	PM_{10}	NO_x	SO_x	NH_3
Area	21772	1717	77	6259
Non-road	634	6500	1557	10
on-road	26357	9932	418	184
Point	1173	1796	1715	405
Total	**49936**	**19945**	**3767**	**6859**

The annual average inventory indicates that area and on-road mobile sources are the dominant sources of primary PM_{10} concentrations. Within the area sources of PM_{10}, fugitive dust from construction and agriculture accounts for 37% of the total annual PM_{10} emissions. Road dust from paved and unpaved roads contributes another 51% of total PM_{10} concentrations.

4.2.1. Source Profiles

Source profiles are calculated by collecting and analyzing the primary PM_{10} fraction of specific emissions. Chemical species within each profile are presented as a fraction of the total PM_{10} samples collected. In this way, speciated emissions can be estimated by multiplying the source-specific profile by the PM_{10} emissions from that source. The Pacific Northwest Source Composition Library (Core, et al., 1989), compiled during the late 1980s, contains chemical profiles pertinent to the major primary PM sources in the Treasure Valley. Since vehicle exhaust and wood burning profiles have probably changed over time, source profiles from other studies, in Phoenix, Arizona and Las Vegas, Nevada are used for these sources (Chow, et al., 1991; and Chow and Watson, 1997).

Figure 4-4 shows the PM_{10} source profiles used in the speciated rollback modeling. The source types on the left side of the figure are fugitive dust sources. Combustion sources are shown on the right side of the figure. Fugitive dust sources are composed primarily of geologic material and organic compounds. Combustion sources have lower levels of geologic material and higher levels of organic and elemental carbon material. Note that for some profiles, the sum of the principal components exceeds 100%. This is an artifact of the uncertainties of the components of the profiles. These uncertainties are propagated in calculating the speciated emissions inventory and are reflected in the overall uncertainty of the modeling results. Each of the profiles in the figure is matched with a source category to produce the speciated emissions (see **Table 4-5**).

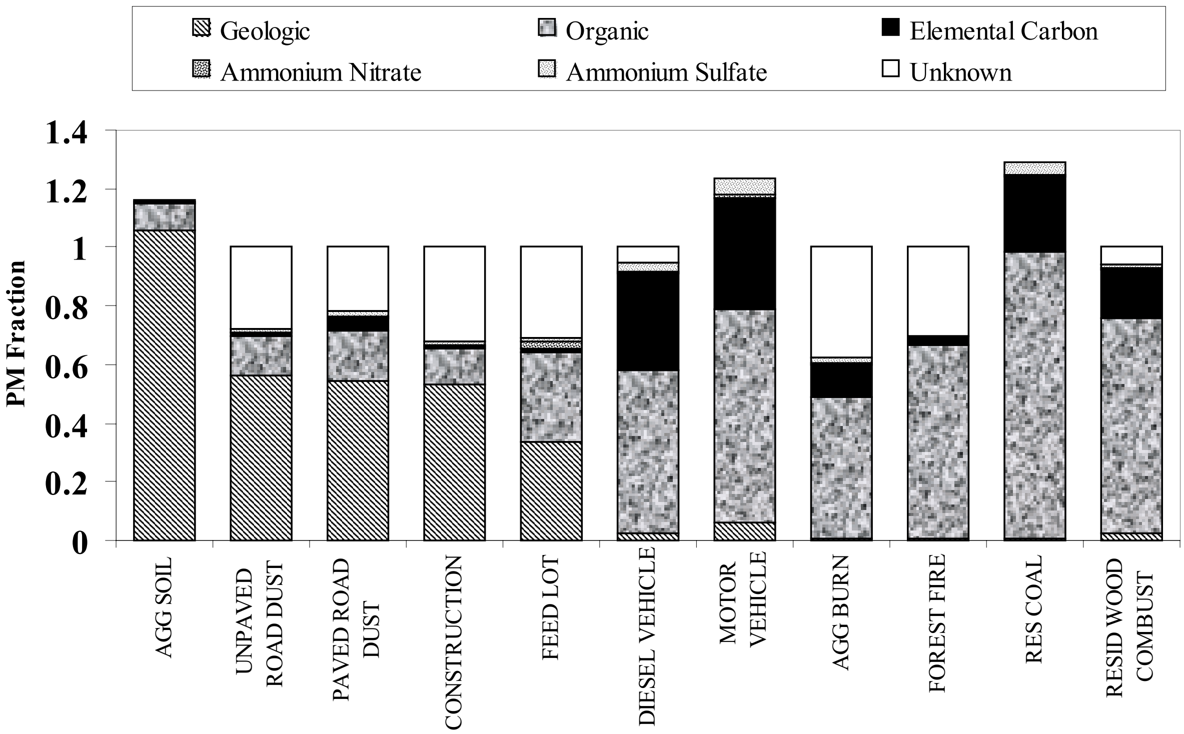


Figure 4-4 Source profiles used for converting total emissions of primary PM_{10} into speciated emissions of PM_{10}.

4.2.2. Assembling the Speciated Inventory

Primary emissions of PM_{10} are multiplied by source profiles relevant to each individual source in order to generate speciated PM_{10} emissions. In this analysis, no production of secondary aerosols was assumed. With this assumption, the speciated emission inventory is calculated as simply the product of primary PM_{10} emissions and their corresponding source profile. **Table 4-5** shows the profile paired with each source category used to calculate the speciated primary emissions inventory. Some sources such as residential natural gas could not be matched with available source profiles. In all cases, these sources were negligible fractions of primary PM_{10} emissions and were labeled ZERO to indicate that they were omitted as sources of primary PM_{10} emissions. The ZERO profile effectively ignores the primary PM_{10} emissions from a given source; however, precursor emissions of SO_x, NO_x, and NH_3 remain in the emissions inventory.

This emissions inventory is considered valid for most days when the Treasure Valley is well ventilated and there is insufficient time to form significant amounts of secondary aerosol before emissions leave the airshed.

Table 4-5 Source profiles matched to primary emissions of source categories in Treasure Valley.

Source Type	Source Category	Profile of Primary Particles
Area	Residential Wood - Fireplaces	RESID WOOD COMBUST
Area	Residential Wood - Wood Stoves	RESID WOOD COMBUST
Area	Residential Wood - BBQ/Firepits	RESID WOOD COMBUST
Area	Residential Natural Gas	ZERO
Area	Residential Propane	ZERO
Area	Residential Fuel Oil	ZERO

Area	Residential Coal	RES COAL
Area	Comm./Inst. Natural Gas	ZERO
Area	Comm./Inst. Propane	ZERO
Area	Comm./Inst. Fuel Oil	ZERO
Area	Comm./Inst. Coal	RES COAL
Area	Industrial Natural Gas	ZERO
Area	Industrial Propane	ZERO
Area	Industrial Fuel Oil	ZERO
Area	Open Burning	AGG BURN
Area	Structural Fires	FOREST FIRE
Area	Vehicle Fires	FOREST FIRE
Area	Other Fires	FOREST FIRE
Area	Wildfires	FOREST FIRE
Area	Construction - Residential	CONSTRUCTION
Area	Construction - Commercial	CONSTRUCTION
Area	Agricultural Tillage	AGG SOIL
Area	Agricultural Harvesting	AGG SOIL
Area	Agricultural Windblown Dust	AGG SOIL
Area	Cattle Feedlots	FEED LOT
Area	Livestock Ammonia	ZERO
Area	Wind Erosion of Natural Habitats	AGG SOIL
Area	Microbial NO	ZERO
Area	Small Industrial Sources	ZERO
Non-road Mobile	Commercial Aircraft	MOTOR VEHICLE
Non-road Mobile	General Aviation	MOTOR VEHICLE
Non-road Mobile	Military Aviation	MOTOR VEHICLE
Non-road Mobile	Airport Ground Support Equipment	DIESEL VEHICLE
Non-road Mobile	Lawn & Garden Equipment	MOTOR VEHICLE
Non-road Mobile	Recreational Equipment	MOTOR VEHICLE
Non-road Mobile	Light Commercial Equipment	MOTOR VEHICLE
Non-road Mobile	Industrial Equipment	MOTOR VEHICLE
Non-road Mobile	Construction Equipment	MOTOR VEHICLE
Non-road Mobile	Agricultural Equipment	DIESEL VEHICLE
Non-road Mobile	Recreational Marine Vessels	MOTOR VEHICLE
Non-road Mobile	Locomotives	DIESEL VEHICLE
Mobile	On Road Mobile Emissions (Exhaust and Tire Wear)	MOTOR VEHICLE
Mobile	Paved Road Dust	PAVED ROAD DUST
Mobile	Unpaved Road Dust	UNPAVED ROAD DUST
Point	Industrial < 1 tpy	CONSTRUCTION
Point	1tpy < Industrial < 2 tpy	CONSTRUCTION
Point	Industrial >2 tpy	CONSTRUCTION

Table 4-6. Speciated Emissions for Ada and Canyon Counties (tons/year)

	1999	*2010*	*2015*	*2020*	*2030*
Geologic	27389	32078	35657	35511	39300
Organic	8687	10585	12224	12297	13658
Elemental Carbon	1953	2313	2765	2786	3170
Ammonium Sulfate	931	1096	1266	1267	1429
Ammonium Nitrate	613	722	826	830	921
Total (see note)	49939	61297	69867	69895	73968

Note: The speciated data were generated using the source profiles collected in the various locations nationwide. The total emissions were emission inventory by Environ International Corporation. The summation of speciated mass is not equal to the total. 2015 on road emission is equal to 2020 on road emission.

5. ROLLBACK MODEL DESCRIPTION

A spreadsheet format is used to assemble the speciated rollback model. Tables of speciated concentrations, emissions inventories, and source profiles have been placed in separate worksheets within a single workbook. Raw data from these tables are reduced to emissions and concentrations of the geologic material, organic carbon, elemental carbon, ammonium sulfate, and ammonium nitrate components. Another worksheet is used to integrate all of the data in the workbook. This worksheet contains a rollback matrix in which emissions reduction strategies can be evaluated against the base case emissions. On the same sheet are component summaries of total emissions for each of the three emissions cases (no secondary formation, NO_x limited, and NH_3 limited), ambient PM_{10} components for both the high and stagnation aerosol types, and background concentrations profiles.

Modeled PM_{10} component concentrations are calculated using the following equation:

$$C_i^f = \left(\frac{E_i^f}{E_i^b}\right)(C_i^b - bg_i) + bg_i \qquad (12)$$

where E_i, C_i, and bg_i are the emissions, concentrations, and background concentrations of component i. The superscripts f and b indicate future (controlled) and base cases.

The unknown component of the controlled PM_{10} is assumed to have the same proportion to total PM_{10} as the base case. That is, if 15% of the ambient aerosol composition is unknown, then 15% of the modeled aerosol composition is also unknown.
Quantitative uncertainties of the rollback model results are estimated based on the uncertainties of the variables used to calculate C_i^f. Specifically, the equation used to calculate the rollback uncertainty is:

$$\sigma_{C_i^f} = \sqrt{\left(\frac{C_i^b \Delta E\, \sigma_{E_i^b}}{\left(E_i^b\right)^2}\right)^2 + \left(\frac{\Delta E\, bg_i}{E_i^b}\right)^2 \left(\left(\frac{\sigma_{E_i^b}}{E_i^b}\right)^2 + \left(\frac{\sigma_{bg_i}}{bg_i}\right)^2\right)}. \qquad (13)$$

Where ΔE is the change in emissions E_i^f - E_i^b, σ_E is the uncertainty of the total base year emissions of species i, and σ_{bg} is the standard deviation of the background concentration. SAI made no estimates of uncertainty of the emissions inventory generated in 1998. For use in the rollback modeling, the uncertainty of the emissions from each source category was arbitrarily chosen to be 25%. This number may grossly underestimate the uncertainty of the more intermittent sources such as fugitive dust and wildfires. The same estimation was assumed for the emission inventory conducted by Environ.

A more detailed description of the design and application of the speciated rollback spreadsheet will be provided in a users manual that will accompany this report.

6. MODEL APPLICATION AND RESULTS

6.1. Projected PM_{10} Changes (1999 – 2030)

Estimates of future aerosol concentrations can be generated using the speciated linear rollback model by changing the emissions inventory to reflect anticipated changes in emissions.
As mentioned earlier, future industrial emissions were based on maximum potential emissions for unpermitted facilities and maximum allowable emissions for permitted facilities. It is therefore likely to overestimate future emissions for these sources. From 2010 to 2020, industrial emissions are projected to remain at the same maximum potential level as in 2000.

Hence, changes in projected concentrations between 2000 and 2030 are based on increases in mobile and area emissions due to population and economic growth. The rollback modeling predictions are shown in Table 6-1 and Figure 6-1. The pollutants are categorized into five groups. Since the all source profiles available were collected in wintertime, the secondary aerosols are likely overestimated, and the geologic PM_{10} concentration is underestimated in these results. To determine the trend over the past years, the annual average PM_{10} concentrations are plotted in Figure 6-2. The annual average concentration decreased from 1994 through 1998, and increased in 1999 and 2000. This trend is likely driven by the weather patterns. Figure 6-3 shows the annual average of measured PM_{10} at Boise Fire Station #5 (this site is used because it has the highest sampling frequency, and a more complete record) excluding the days that make up the highest 10%. The level is almost constant during these years. Most of the 10% of days with highest concentrations occur during winter stagnation scenarios and fall smoke events. Excluding these high-concentration days, the annual average remains constant.

Table 6-1. The predicted levels by rollback model (μg/m^3). 1999 PM_{10} value is measured.

Pollutant	1999	2010	2015	2020	2030
Geologic	10.9	12.3	12.9	13.4	14.6
Organic	6.3	7.5	8.1	8.6	9.4
Elemental Carbon	1.7	2.0	2.2	2.4	2.7
Ammonium Sulfate	1.7	1.9	2.0	2.1	2.3
Ammonium Nitrate	3.2	3.7	4.0	4.2	4.6
PM_{10}	29.4	34.0	36.1	38.0	41.8

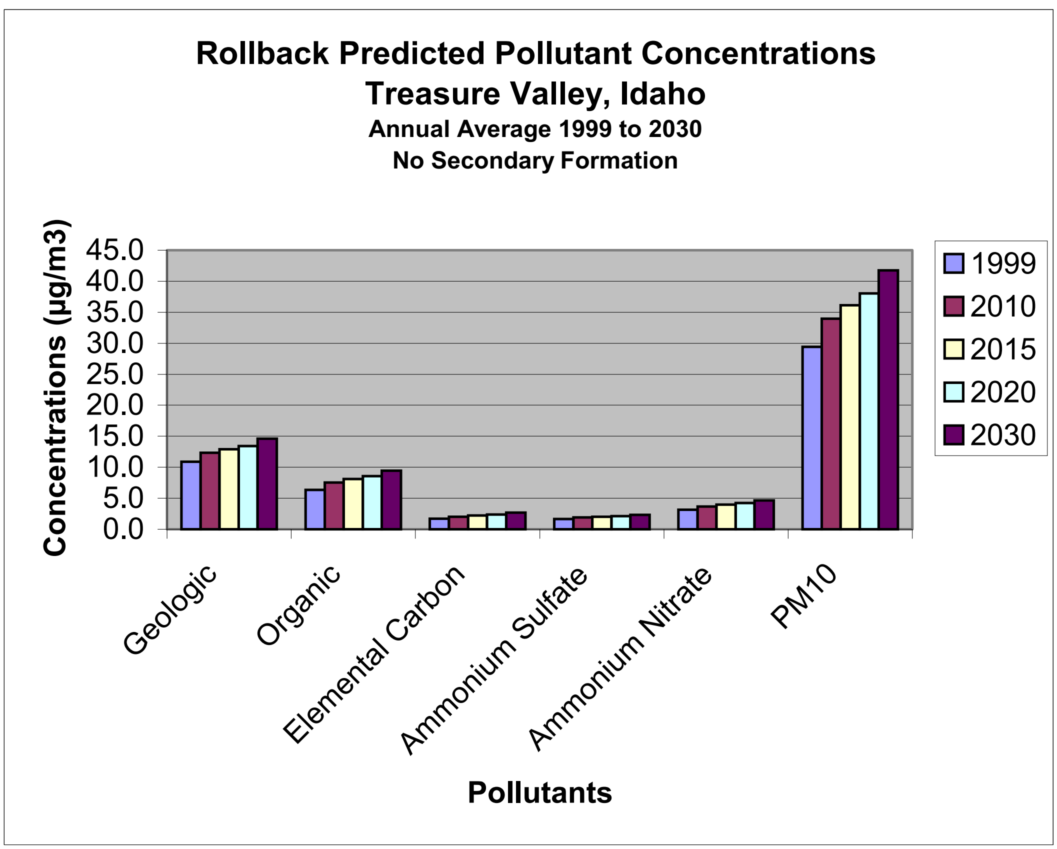


Figure 6-1. The predicted annual average PM_{10} concentrations in five categories.

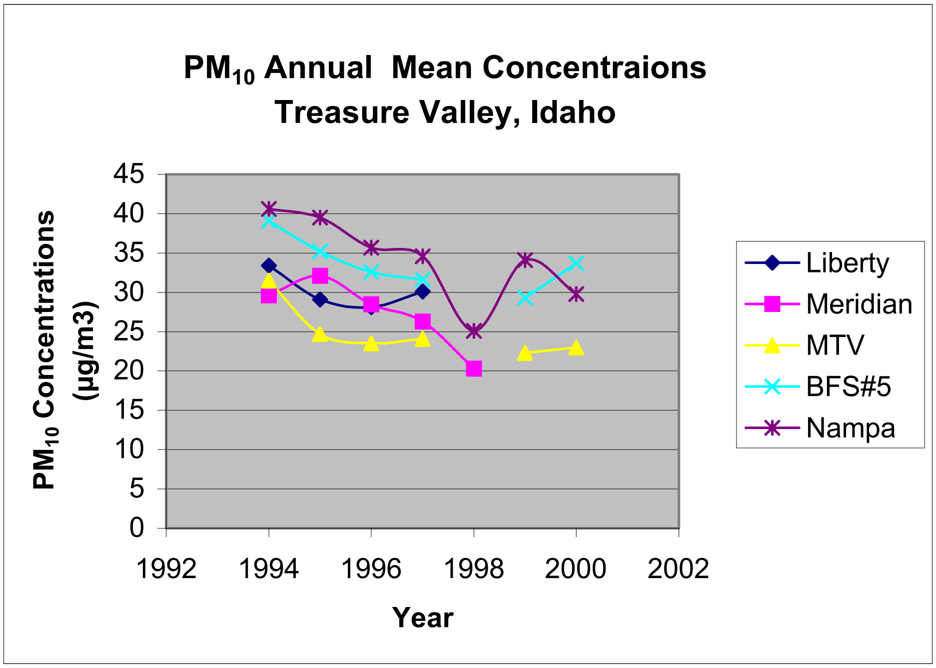


Figure 6-2. PM_{10} Annual Mean Concentrations in Treasure Valley

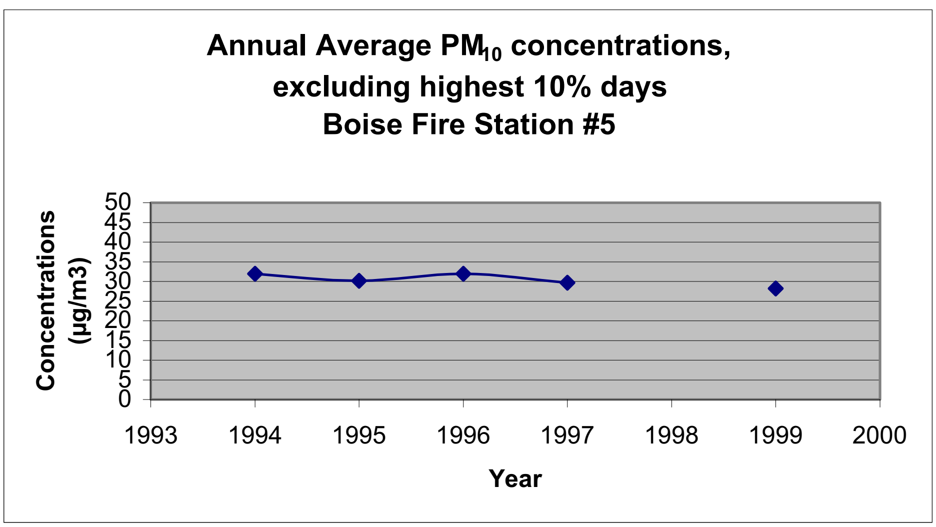


Figure 6-3. Annual Average PM_{10} concentrations, excluding highest 10% days, Boise Fire Station #5

The main PM_{10} pollutant on typical days is geologic material, which primarily consists of coarse particles that will fall out near the source. Therefore, if the emissions intensity (kg per area) remains constant, the average PM_{10} levels may not increase proportionally to the projected total emissions increase.

6.2. Limitations of the Speciated Rollback Model

The numerical uncertainties associated with source attributes are a composite of the background aerosol variability, the source profile uncertainty, and an arbitrarily chosen uncertainty factor (25%) of the emissions for each source category. These values should not be used as confidence bounds on the effectiveness of the various control strategies since there is no justification for choosing the uncertainty of the emissions estimates. As mentioned earlier, the strengths of some sources are highly variable from day to day. The 25% emission uncertainty allotted to each source may not represent the true variability of the source strengths. Scientifically based quantification of the uncertainty of each component of the emissions inventory is necessary to estimate a confidence interval for the effectiveness of control strategies derived from the speciated rollback model.

6.3. Evaluation of Ambient Concentrations and Speciated Emissions Inventories

Although, the secondary aerosol formation was not considered in this modeling, the general concepts are discussed below for reference.

Precursor emissions form secondary aerosol at a variable rate depending on several factors including relative humidity, solar radiation, and temperature. Consequently, a consistent relationship between emissions and concentrations for ammonium sulfate and ammonium nitrate is not expected. For the speciated rollback analysis, geologic material, organic compounds, and elemental carbon are all assumed to be conservative species, that is, once they are emitted as primary aerosol, they do not undergo chemical transformation prior to deposition. This assumption and the validity of the emissions and concentrations data sets may be tested by comparing the ratio of primary speciated emissions to the speciated aerosol concentrations. For conservative components, it is expected that the ratio of emissions to ambient concentrations (minus the background concentrations) should be similar for all components. 2 compares these ratios between species for two cases: the 1990 Stagnation Inventory paired with the Stagnation Aerosol Profile, and the 1995 Average Winter Day Inventory paired with the High Winter Aerosol Profile.

Table 6.3-1 Ratio of emissions to ambient concentrations minus the background concentrations for conservative aerosol components for stagnation conditions in 1990 and the average winter day in 1995.

	(Stagnation Emissions 1990) /(Stagnation Aerosol Conc. - Background Conc.) (tons/yr)/(μg/m^3)	(Average Winter Day Emissions 1995)/(High Winter Aerosol Conc. - Background Conc.) (tons/yr)/(μg/m^3)
Geologic Material	523	507
Organic Material	237	259
Elemental Carbon	213	179

The table indicates that the emissions to concentration ratios for geologic material are more than twice as high as the same ratios for organic material and elemental carbon. If there are no biases associated with the PM_{10} speciated measurements, these results suggest that either the estimated emissions of geologic materials from the emissions inventory are too high or that the emissions estimates of both organic material and elemental carbon are too low. This discrepancy between emissions and ambient profiles signals that there may be a problem with the assumptions used to create the speciated emission inventory. Sources of error in the speciated emissions inventory include:

- Variable fugitive dust emissions. The strengths of these sources are dependent on parameters such as maximum wind speed and ground moisture. Consequently, actual fugitive dust emissions are highly variable from day to day. Given the relatively small number of speciated aerosol measurements used for comparison with the inventories, a significant agreement between seasonally averaged speciated emissions and concentration profiles should not be expected.

- Inappropriate source profiles for agricultural dust and road dust. Agricultural dust and road dust account for 70% of the primary wintertime PM_{10} emissions. The emissions of geologic and organic material are very sensitive to the profiles chosen for these sources. The speciated profiles applied to these sources were collected in the Kern Wildlife Refuge in California and Las Vegas, Nevada. Differences in the distribution of organic and geologic material may exist between the sources from these locations and the Treasure Valley.

Recommendations to better understand and resolve these discrepancies are discussed in Section 8.

7. SUMMARY AND CONCLUSIONS

Speciated rollback modeling was applied to Treasure Valley PM_{10} analysis. The analysis predicted PM_{10} levels through the year 2030. The predictions are based on the 1999 monitored data collected at Boise Fire Station No.5 (where the highest concentrations in the valley have been observed) projected population growth, and potential industrial emissions. Emissions inventories for PM_{10}, NO_x, SO_x, NH_3, and chemical source profiles were used to create speciated emissions inventories for geologic material, organic mass, elemental carbon, ammonium sulfate, and ammonium nitrate.

Projections of future PM_{10} trends are likely to be higher due to the EPA-required estimation techniques for projected industrial emissions. Despite these limitations, the effects of future control strategies can be tested by capping industrial emissions estimates at some multiple of their 1995 levels.

The annual average concentration varies from year to year. This is primarily due to the weather patterns. The high-concentration days during winter stagnation scenarios and the smoke events during summer and fall have significant impact on the annual average concentrations. According to the data collected from1994 through 2000 (Figure 6-3), the PM_{10} concentration (excluding the highest 10%) remained constant, although the area was growing consistently. The predicted level for year 2030 is 42 $\mu g/m^3$.

8. RECOMMENDATIONS

The results of this analysis have raised additional questions about sources of PM_{10} in the Treasure Valley. Since the high PM_{10} concentration events during winter and fall seasons have significant impact on the annual average concentrations, questions about the 24-hour average are also important. Recommendations are provided here as potential answers for the following questions:

- **Could another stagnation event similar to the one in early January, 1991 (1/4/91-1/7/91) occur and cause exceedances of the 24-hour PM_{10} NAAQS, and drive the annual average higher?**

  The recorded annual PM_{10} average indicated that the levels remain virtually constant at about 30 µg/m^3 when the influence of weather pattern is excluded, based on this information, and the fact that the annual average concentration has never exceeded the standard in the past, it is save to conclude that the exceedance is unlikely to occur in the foreseeable future, although the actual level will alter from year to year. Long-term meteorological records should be researched to determine the frequency and causes of such severe stagnation episodes.

- **Is ammonia concentration in the Treasure Valley limited during winter months?**

  If livestock are the single primary source of ammonia emissions in the Treasure Valley as the emissions inventory suggests, and if background concentrations of ammonia are sufficiently low, controlling ammonia in the Treasure Valley may be a very cost-effective method for reducing secondary ammonium nitrate. The recent studies show that the ammonia is not the limiting factor, and the secondary aerosol formation maybe limited by the VOC emissions.

- **What should be done to create more confidence in the rollback modeling results?**

  A limited amount of speciated data was available for use in the rollback model. Both source and receptor data could be improved by (1) determining the uncertainty of the emissions from the major source categories, (2) collecting speciated source profiles within the Treasure Valley for major sources based on the PM_{10} emissions inventory and (3) routinely measuring the chemical composition of PM_{10} throughout the Treasure Valley. In particular, the discrepancy between the geologic emissions and geologic aerosol component needs to be resolved. For annual average study, the year around source profiles from the area are needed.

- **What can be done to reduce the annual average concentrations?**

  As mentioned, the annual average concentrations are driven by the intensity of emissions and the weather conditions. While controlling the total emissions is important, avoiding the emission sources being concentrated in hot spots is also essential. All control measures for winter stagnation scenarios are important for reducing annual average concentrations. Control of burning activities and reducing mobile emissions in summer and fall, is also essential.

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10. APPENDIX ROLLBACK EPISODE MODELING

Rollback analysis was also performed for winter episodes to reconcile the dispersion modeling results. Since 1999 winter episode was considered as a high PM_{10} winter event, but not a sever stagnation event, the similar 1995 data were used as a reference in the modeling. The modeling results are shown in Table A1and A3. The emission data are shown in table A2 and A4. The emission data were prepared by ENVIRON International Corporation. No exceedances were predicted in this analysis.

Table A1 The predicted PM10 concentrations for winter episodes with snow cover. (µg/m^3)

Case 1: No Secondary Aerosol	**1999**	**2010**	**2015**	**2020**
Geologic	26.0	18.7	20.3	21.9
Organic	15.1	10.3	11.2	12.1
Elemental Carbon	4.1	2.6	2.9	3.1
Ammonium Sulfate	4.0	2.7	2.9	3.2
Ammonium Nitrate	7.5	4.8	5.3	5.8
PM10	**70.3**	**48.4**	**52.9**	**57.2**
Case 2: NOx Limited				
Geologic	26.0	18.7	20.3	21.9
Organic	15.1	10.3	11.2	12.1
Elemental Carbon	4.1	2.6	2.9	3.1
Ammonium Sulfate	4.0	8.3	8.5	8.6
Ammonium Nitrate	7.5	14.4	13.4	12.9
PM10	**70.3**	**67.3**	**69.7**	**72.7**
Case 3: NH3 Limited				
Geologic	26.0	18.7	20.3	21.9
Organic	15.1	10.3	11.2	12.1
Elemental Carbon	4.1	2.6	2.9	3.1
Ammonium Sulfate	4.0	8.3	8.5	8.6
Ammonium Nitrate	7.5	2.5	2.4	2.3
PM10	**70.3**	**52.5**	**56.1**	**59.6**

Table A2. Emission for winter episodes with snow cover. (Tons/day)

YEAR	**PM10**	**NOX**	**SOX**	**NH3**
1999	73	40	12	17
2010	51	78	28	18
2015	56	72	29	18
2020	61	70	29	18

It was assumed there was no road dust due the snow cover on the ground to simulate the 1991 stagnation conditions. The model was also run for high winter conditions in which there is no snow cover on the ground. The results are shown in table A3. The emission increase from the year of 1999 was based on the annual increase ratio. The emissions are shown in table A4.

Table A3. Rollback results for episode without snow cover. (µg/m^3)

Case 1: No Secondary Aerosol	**1999**	**2010**	**2015**	**2020**
Geologic	26.0	34.8	38.5	42.1
Organic	15.1	19.4	21.6	23.4
Elemental Carbon	4.1	5.1	5.6	6.2
Ammonium Sulfate	4.0	5.0	5.6	6.1
Ammonium Nitrate	7.5	9.7	10.8	11.8
PM10	**70.3**	**91.7**	**101.8**	**111.1**
Case 2: NOx Limited				
Geologic	26.0	34.8	38.5	42.1
Organic	15.1	19.4	21.6	23.4
Elemental Carbon	4.1	5.1	5.6	6.2
Ammonium Sulfate	4.0	13.3	13.4	13.5
Ammonium Nitrate	7.5	16.8	16.2	15.8
PM10	**70.3**	**110.8**	**118.2**	**125.3**
Case 3: NH3 Limited				
Geologic	26.0	34.8	38.5	42.1
Organic	15.1	19.4	21.6	23.4
Elemental Carbon	4.1	5.1	5.6	6.2
Ammonium Sulfate	4.0	13.3	13.4	13.5
Ammonium Nitrate	7.5	0.3	0.3	0.3
PM10	**70.3**	**90.4**	**98.5**	**106.0**

Table A4. The emissions for winter episodes with road dust. (tons/day)

Year	**PM10**	**NOX**	**SOX**	**NH3**
1999	73	40	12	17
2010	100	91	46	19
2015	111	88	46	19
2020	122	86	46	20

Appendix F

Treasure Valley Road Dust Study,
Final Report, Desert Research Institute

TREASURE VALLEY ROAD DUST STUDY: FINAL REPORT

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EXECUTIVE SUMMARY

The Idaho Department of Environmental Quality (IDEQ) contracted the Desert Research Institute (DRI) to perform an on-site field study, named the Treasure Valley Road Dust Study (TVRDS). The specific objectives of the study were to 1) assemble a PM_{10} and $PM_{2.5}$ emissions inventory for the years 2000, 2010, 2015, and 2020 as well as for two specific week-long intervals in 1991 and 1999 , 2) assess the spatial and temporal variabilities of emissions in the Treasure Valley, 3) characterize the effects of road sanding and street sweeping, and 4) obtain chemical source profiles of $PM_{2.5}$ and PM_{10} emissions.

The field study was divided into a winter portion (2/21/01-3/17/01) and a summer portion (7/10/01-7/24/01). The field campaign included measurements of silt loadings on Treasure Valley roads, TRAKER street surveys, multiple measurements on a set of roads (TRAKER loop), and two controlled experiments that were coordinated with personnel at the Ada County Highway District (ACHD).

The TRAKER, a vehicle-based device for real-time measurement of dust emissions from roads, was used extensively as part of the study. Street surveys conducted with the TRAKER, totaling 430 km each in winter and summer, were the basis for spatial analysis of road dust emissions. For paved roads, the potential for roads to emit dust was found to vary by county, season, and setting (urban or rural). However, the dust emissions potential was most sensitive to the speed of vehicles that travel on the road. Roads associated with higher speeds were substantially cleaner, in terms of the potential to emit road dust, than those associated with lower speeds. Emissions potentials averaged over the Treasure Valley for paved roads were 0.5 g/vkt/mps whereas for unpaved roads they were 8.6 g/vkt/mps. Practically, this means that if vehicles are traveling at the same speed, emissions from unpaved roads would be 17 times higher than emissions from paved roads.

A closed loop of roads was traversed with the TRAKER 7 times in the winter and 5 times in the summer in order to assess temporal variabilities in road dust emissions. The emissions potentials of paved roads decreased steadily over the winter season, but remained constant over the summer season.

Results from a controlled experiment showed that in the short-term (one or two days), road sanding does not have a significant impact on PM_{10} emissions. On a mass basis, the total amount of road sand applied to Ada County roads was not sufficient to account for all of the increase in winter road dust emissions compared to summer. This suggests that there are other significant sources of wintertime road dust such as trackout/carryout of mud and dirt from unpaved lots and driveways. The elucidation of sources of road dust was recommended for further investigation in future research.

Experiments were conducted in both winter and summer to assess the effectiveness of street sweepers used by ACHD in reducing PM_{10} emissions from roads. Results from those experiments indicated that while excellent at removing large debris and sand-sized grains, the street sweepers had little or no short-term benefit in terms of reducing PM_{10} dust emissions. However, there may be long-term benefits such as the removal of road sand that might otherwise become a source of PM. We note that at present, the mechanisms and extent to which larger sized grains can be ground by the tires of passing vehicles to smaller, suspendable PM_{10}-sized particles is poorly understood.

The TRAKER loop data combined with meteorological observations showed that precipitation has a multiple-day effect on unpaved roads. On the day of precipitation, emissions were reduced to 8% of the equivalent value for the road under dry conditions. On the day following precipitation, emissions were at 35% of those for the dry road. On subsequent days, emissions returned to the dry road value.

The Traffic Demand Model networks for the year 2000 and future years were used in conjunction with TRAKER street surveys to arrive at a road dust emissions inventory for the Treasure Valley. For paved roads, year 2000 emissions during an average winter weekday were 81 metric tons per day, 31% higher than the emissions calculated on an annual average basis. 75% of paved road emissions originated in Ada County and 25% originated from Canyon County. Emissions on an annual average basis increased from year 2000 values by 26%, 42%, and 58% in 2010, 2015, and 2020, respectively. Unpaved road dust constituted 3.9% of all road dust emissions in the Treasure Valley on an annual average basis.

The TRAKER-based emissions inventory for road dust assembled as part of this study yielded somewhat higher values for road dust than was reported in a prior inventory prepared by SAI (1997). The SAI inventory used the default values for silt loading recommended by the EPA AP-42 document. Calculation of emissions using the EPA AP-42 method with silt loadings measured on-site in the Treasure Valley yielded higher emissions than those calculated using the default values for silt loading.

PM_{10} and $PM_{2.5}$ resuspension samples were collected from paved and unpaved roads, ACHD road sand used for wintertime traction control, and dust generated as part of the chip-sealing process. Samples were analyzed for chemical content and source profiles were constructed. Paved road source profiles were enriched in organic and elemental carbon compared with source profiles from unpaved roads. ACHD road sand contained a higher fraction of soluble sodium, chloride, and sulfate than material collected from paved roads. Source profiles for chip-sealing material did not differ significantly from those for unpaved roads.

Areas highlighted for future work include better assessment of the deposition of dust during transport between the point of emissions and air quality monitors, further investigation into the origin and fate of road dust- with special attention to elevated emissions in winter-, and a more comprehensive assessment of the effectiveness of street sweepers in curbing paved road emissions.

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1. INTRODUCTION

1.1 Background

The Idaho Division of Environmental Quality (IDEQ) seeks to better understand the effect of fugitive dust emissions from paved and unpaved roads on ambient concentrations of PM_{10} (suspended aerosol particles with aerodynamic diameter of 10 ?m or less). Because of exceedances of the 24-hour PM_{10} National Ambient Air Quality Standard in 1988, 1989, and 1991, Ada County was designated as a moderate PM_{10} non-attainment area. Previous source apportionment studies in the Treasure Valley indicate that PM_{10} particles of geologic origin, a category that includes road dust and windblown dust from open fields, can comprise 25%- 60% of the measured PM_{10} during the Winter (Kuhns et al., 1998). An emissions inventory assembled for the Treasure Valley (SAI, 1997) indicated that in the wintertime, paved and unpaved road dust is responsible for 75% of primary PM_{10} emissions. On an annual average basis, the emissions inventory indicates that road dust is responsible for approximately 30% of primary PM_{10} emissions. These emissions inventories use national default values for the emissions potential of Treasure Valley roads. The default values are prescribed by the US EPA (EPA, 1999; EPA, 1995) and represent aggregated, statistically averaged data from across the United States. The importance of road dust as a source of ambient PM_{10} in the Treasure Valley warranted a more comprehensive investigation of the magnitude of emissions based on locally derived parameters that are representative of roads in Ada and Canyon Counties.

Road dust falls under the larger category of fugitive dust emissions. Fugitive dust sources include erosion of soils, paved and unpaved roads, active storage piles, and construction activities. The AP-42 (EPA, 1999) outlines a method for estimating dust suspension from roads by measuring the amount of silt present on those roads (nominally particles with physical diameters of 75 ?m or less). It is not practical or economical to perform a large number of these measurements. Consequently, the paucity of samples is frequently not representative of the road conditions across an air shed, either spatially or temporally.

This study combines the traditional silt loading with a new, vehicle-based technique that allows for estimation of road dust emissions potential over a large spatial extent in a relatively short period of time. The field-sampling program took place in Ada and Canyon Counties and was divided into a winter and summer portion allowing for an estimate of temporal variability of dust emissions. Because of the economy of the measurement method, it was possible to evaluate effects of human intervention and environmental factors on dust suspension from roads. In this study, the effects of street sweeping, application of traction control substances, and meteorological events such as wind and precipitation were investigated. The results of the field study were combined with data available from local transportation planning authorities to estimate emissions from paved and unpaved roads in the Treasure Valley.

1.2 Study Objectives

The objectives of the Treasure Valley Road Dust Study were:

?? To collect sufficient data within the Treasure Valley to resolve spatial and temporal trends in road dust emissions.

?? To generate a spatially resolved PM_{10} emissions inventory of paved and unpaved road dust for base and future years.

?? To assess the impact of wintertime application of traction control materials, street sweeping, and the occurrence of certain meteorological events on road dust emissions.

?? To collect and chemically analyze road dust samples for use in Chemical Mass Balance (CMB) receptor modeling.

1.3 Technical Approach

The objectives of this study were accomplished through a combination of field data collection, laboratory analysis, data processing, and modeling.

1.3.1 Field Data Collection

The Treasure Valley Road Dust Study used primarily locally-collected data to estimate road dust emissions. All the fieldwork for this project occurred in 2001 and was divided into a winter (2/26/01–3/17/01) and a summer (7/11/01–7/26/01) portion. The field study consisted of multiple components including procurement of road dirt samples for silt and source profile analyses of road dust, surveys of streets in the Treasure Valley with the TRAKER vehicle (see below) to assess spatial distributions of road dust emissions factors, repeated TRAKER measurements of road dust emissions factors over the same set of streets on 12 different occasions to assess temporal variability, and two intensive experiments to test the effects of wintertime road sanding and street sweeping on road dust emissions factors.

1.3.1.1 Silt Sampling

The AP-42 (USEPA, 1999) prescribes the use of silt measurements for estimation of emissions factors from both paved and unpaved roads. Silt is defined operationally as the material that can pass through a 200 mesh sieve (nominally corresponding to particles with diameters of 75 ?m or less). Silt content is used to estimate emissions from unpaved roads and is defined as the ratio of silt mass in the sample to the total mass in the sample. In contrast, the silt loading which is used to calculate emissions from paved roads is defined as the mass of silt per unit area of road. Sample collection involves securing the test area from passing vehicles and carefully sweeping and vacuuming three measured strips of roadway that run perpendicular to the direction of traffic. Road soil samples were collected for silt analysis during the wintertime and summertime from a variety of road classes throughout the Treasure Valley.

1.3.1.2 TRAKER

TRAKER (Testing Re-entrained Aerosol Kinetic Emissions from Roads), developed at the Desert Research Institute (DRI), is a new method for measuring the emissions potential from roads (Kuhns et al., 2001). TRAKER consists of a vehicle fitted with particle measuring instruments that draw air from behind the front tires. The on-board instruments log the particle concentration behind the tire and the GPS coordinates of the measurement every 1 second of operation. The advantage of the TRAKER over traditional silt loading methods is that hundreds of thousands of measurements of suspendable PM_{10} can be obtained in a relatively short period of time over a large spatial domain. This allows for a more representative sampling of road dust emissions than can be practically obtained with traditional silt measurements.

In this study, the TRAKER was used in three ways. First, the TRAKER was used to survey over 400 km of roads during each of the two sampling seasons in Ada and Canyon Counties. Second, the TRAKER was used to assess seasonal trends in the dust emitting potential as well as the effects of application of traction control substances, street sweeping, and precipitation on PM_{10} emissions from roads over the Treasure Valley. Third, TRAKER data were the basis for assembling year 2000 and future year PM_{10} and $PM_{2.5}$ emissions inventories for road dust.

1.3.2 Laboratory Analysis

Road soil samples collected in the field were sent to DRI's Environmental Analysis Facility in Reno, NV for analysis. Samples were sieved and weighed to determine the silt content of the road soil. The silt contents were then used to calculate the silt loading on each of the road sampled. Select silt samples were also resuspended in a specialized chamber to collect only the PM_{10} and $PM_{2.5}$ fraction of the material on filter substrates. These filters were chemically analyzed to produce source profiles for future use in CMB receptor modeling.

1.3.3 Data Processing

TRAKER collects data from 10 separate onboard instruments every second of operation. These data are synchronized with each other and are quality assured using validation criteria to produce an unbiased measure of the PM_{10} suspended from the road surface at a particular instant. In coordination with a concurrent study of unpaved road dust emission (Gillies, 2000), the TRAKER measurement was calibrated with horizontal particle flux measurements. The product of the calibration study enabled the estimation of a road dust emissions potential for all roads surveyed by TRAKER in the Treasure Valley.

The planning association for southwest Idaho (COMPASS) maintains a traffic demand and forecasting model for Ada and Canyon counties. Road dust emissions inventories for the Treasure Valley were prepared by integrating the measured TRAKER emissions potentials with the traffic activity data from the COMPASS traffic demand model. Separate inventories were calculated for wintertime and annual emissions for base and future years.

1.4 Guide to the Report

In this Section, we have stated the background, objectives, and technical approach of the Treasure Valley Road Dust study. In Section 2, the silt sampling and analysis is presented along with the results of the measurements. Section 3 discusses the principles of the TRAKER operation, quality assurance tests, and TRAKER's calibration with upwind-downwind emissions fluxes. The TRAKER measurements in the Treasure Valley including data processing, street surveys, loops, and the effects of street sanding and sweeping are discussed in Section 4. Section 5 documents the preparation of the emissions inventories from the TRAKER data and the silt loading measurements. A preliminary modeling study aimed at estimating the diminishment of PM_{10} dust fluxes with downwind distance from the source is presented in Section 6. Section 7 summarizes the chemical source profile data measured from the resuspended road soil samples. Summary, conclusions, and recommendations are contained in Section 8. A list of references used throughout this report is given in Section 9. Details of silt loading sites and results, historical meteorological characteristics of the Treasure Valley, and a guide to the electronic format link-level emissions inventories are provided in the appendices to this report.

2. SILT MEASUREMENTS

For this study component, silt samples were obtained from paved and unpaved roads as a means of comparing road dust emissions measured by the TRAKER system to the existing EPA-prescribed method. Thirteen samples were obtained during the winter 2001 portion of the study from both Ada and Canyon County roads; an additional twelve samples were obtained in the summer 2001 portion. Of the winter samples, three were from arterial roads, three from collector roads, three from local roads, and four from unpaved roads. Summer samples had the same distribution except that only three unpaved roads were sampled. Samples from paved roads were analyzed for silt loading, i.e. the amount of silt per unit area of road surface, whereas samples from unpaved roads were analyzed for silt content, i.e. the fraction of the road material that is in the silt size range. In addition, a portion of sand used for wintertime traction control by the Ada County Highway District (ACHD) was also obtained and analyzed for silt content. The ACHD sand was used in later testing of road sanding and street sweeping effects on dust emissions. A description of the use of silt analyses in estimating road dust emissions is given below. The sites sampled and the procedures used are discussed in section 2.1. Results for the silt measurements are summarized in section 2.2. Section 2.2 also draws comparisons between silt measurements as part of the Treasure Valley study and the default silt values used in the 1995 emissions inventory prepared for the Treasure Valley by SAI (1997).

Silt, defined operationally as the material that passes through a 200-mesh sieve (corresponding to approximately 75 ?m in grain diameter), is used widely as a surrogate for PM_{10} road dust emissions. The appropriateness of using silt as a measure of road dust emissions potential is a topic of debate because silt is composed of particles that are greater than 10?m and silt samples are collected in a manner very different from the suspension of dust by tires. At the present time, measurements of silt loading for paved roads and silt content for unpaved roads are the EPA-recommended surrogates for estimating road dust emissions (USEPA, 1999; USEPA, 1995). The AP-42 emissions factor for unpaved roads was (U.S. EPA, 1995):

Eq. 2-1 $R_{ur} = 5.9*k*(Silt/12)*(Speed/30)*(Weight/3)^{0.1}*(Wheels/4)^{0.5}$

where:

$R_{ur,TSP}$ = unpaved road dust emission factor for all vehicle classes combined (grams per mile).

K= a particle size modifier (dimensionless).

Silt=silt fraction content of the surface material (% mass).

Speed=average speed of all vehicle types combined (miles per hour [mph]).

Weight =average weight of all vehicle types combined (tons).

Wheels=average number of wheels per vehicle for all vehicle types combined.

The most recent AP-42 emissions factor (U.S. EPA, 1999) eliminates the speed factor and is specific to PM_{10}:

Eq. 2-2 $EF_{10} = A?(s/12)^{0.8}?(W/3)^{0.4}/(M/0.2)^{0.3}$

where:

A = unpaved road dust emission factor multiplier for PM_{10}: 2.6 lb/VMT or 740 g/VKT.

s = silt fraction of the surface material (% mass).

W = Mean vehicle weight (tons).

M = Surface material moisture content. (%)

This latter formulation of the emissions factor is not used in current inventories and is a subject of controversy because there is clearly a relationship between vehicle speed and emissions in most reported tests.

A control effectiveness modifier due to precipitation is often appended to the unpaved road emission factor equation to estimate annual averages:

$P_{annual,county}$ = PrecipDays/365

where PrecipDays is the number of days per year with greater than 0.01 inches of precipitation. This modifier assumes 100% emissions reduction effectiveness for each day with more than 0.01 inches of precipitation.

For paved roads, the U.S. EPA (1999) emission factor is:

Eq. 2-3 $EF_{10}= k?(sL)^{0.65}?(W)^{1.5}$

where:

k = paved road dust emissions factor multiplier for PM_{10}: 0.56 g/VKT or 0.9 g/VMT.

sL = silt loading of the surface material (g/m^2).

W = mean vehicle weight (tons)

Note that the size fraction is incorporated into the emission factor and that the silt loading rather than the fraction of silt is used. There is no dependence of the paved road dust emission factor on vehicle speed or number of wheels as there is in Eq. 2-1 for unpaved road emissions.

2.1 Methods

2.1.1 Site Selection

Sites for silt sampling were selected to encompass each of four road types, arterial, collector, local, and unpaved, in both Ada and Canyon Counties. Table 2-1 and Table 2-2 list the sample locations and the amount of road dirt that was obtained at each site in winter 2001 and summer 2001, respectively. Figure 2-1 shows where the silt samples were obtained in the Treasure Valley. Detailed maps for each of the sites are provided in Appendix A. Silt samples from paved and unpaved roads were obtained and analyzed according to the instructions in Appendices C1 and C2 of AP-42 (USEPA, 1999).

2.1.2 Sample procurement

Sampling on paved roads required the closure of one or more lanes of traffic. Lane closure permits were obtained from the appropriate municipalities prior to road sampling. At each of the nine paved road sites, three sections of a travel lane were measured, marked off with tape, and documented with the aid of a GPS receiver. Wherever possible, the centers of the road sections were distanced a minimum of 15 m apart to allow for a more representative sample. Sections ranged from 2.6 m to 4.6 m in width (cross-lane direction) and from 0.3 m to 9 m in length (along-lane direction). The width of the sections was determined by including the portion of the lane where vehicle tires travel under normal driving conditions and excluding road shoulders, centerline dividers, and other portions of the road that are not normally traversed by vehicle tires. The lengths of the sections were determined based on the criterion that a minimum of 200 grams of road dirt must be obtained for each section. This criterion was met for most of the winter 2001 samples. However, dirt loadings on roads were much smallerin summer 2001 and frequently it was not practicable to meet this criterion.

Table 2-1 Winter 2001 Silt Sampling Locations, Descriptions, and Mass Sampled

Site	Field Sample ID	Lab ID	Sample Date	Type	Width (m)	Length (m)	Separation Between Sampling Locations (ft)	Area per sampling location (m^2)	Total area for site (m^2)	Net Mass per sampling location (g)	Total mass for site (g)
Riva Ridge North of Reutzel Dr.	BOISL001 BOISL002 BOISL003	RS562	3/1/2001	paved	3.9 4.2 4.1	3.1 3.0 3.0	15.2	12.1 12.6 12.5	37.2	1569 626 407	2601
Apple St. Between Wright and LaFayette	BOISL004 BOISL005 BOISL006	RS565	3/3/2001	paved	3.3 3.3 3.3	3.0 3.0 3.0	15.2	10.1 10.1 10.0	30.2	199 190 231	620
13th St. North of Hays	BOISL007 BOISL008 BOISL009	RS568	3/4/2001	paved	2.4 2.4 2.7	9.1 9.1 9.1	6.1	22.3 22.3 25.1	69.7	133 140 248	522
Front St. Between 3rd and 5th	BOISL010 BOISL011 BOISL012	RS571	3/4/2001	paved	3.8 3.8 4.0	6.1 6.1 6.1	12.2	23.4 23.4 24.5	71.2	210 299 398	907
West Park Dr. West of Milwaukee	BOISL013 BOISL014 BOISL015	RS574	3/6/2001	paved	2.6 2.7 2.8	6.1 6.1 6.1	9.1	16.1 16.4 17.0	49.5	289 228 192	708
Maple Grove North of Tillamook	BOISL016 BOISL017 BOISL018	RS577	3/6/2001	paved	3.4 3.4 3.4	9.1 9.1 9.1	12.2	30.7 30.9 31.1	92.7	174 167 213	554
Garrity Blvd. Between Cavalry and 11th	BOISL019 BOISL020 BOISL021	RS580	3/7/2001	paved	3.6 3.6 3.5	9.1 9.1 9.1	6.1	32.5 33.0 31.8	97.3	348 360 271	978
Amity Between Colorado and Diamond	BOISL022 BOISL023 BOISL024	RS583	3/7/2001	paved	3.9 4.0 3.9	3.0 3.2 3.0	12.2	11.8 13.0 11.8	36.7	198 218 186	603
6th St. Between 6th Avenue and 7th Ave	BOISL025 BOISL026 BOISL027	RS586	3/7/2001	paved	3.5 3.5 3.5	6.1 6.1 6.1	6.1	21.1 21.1 21.1	63.2	1169 1045 2129	4343
Howry	BOISL034 BOISL035 BOISL036	RS589	3/6/2001	unpaved	4.6 4.6 4.6	0.3 0.3 0.3	45.7	1.4 1.4 1.4	4.2	1567 2209 3632	7408
Cloverdale Farm Road	BOISL037 BOISL038 BOISL039	RS592	3/17/2001	unpaved	4.6 4.6 4.6	0.3 0.3 0.3	30.5	1.4 1.4 1.4	4.2	901 1104 724	2728
Pierce Park	BOISL040 BOISL041 BOISL042	RS595	3/16/2001	unpaved	4.6 4.6 4.6	0.3 0.3 0.3	30.5	1.4 1.4 1.4	4.2	1111 1467 1772	4351
Unpaved Driveway Off Happy Valley	BOISL057 BOISL058 BOISL059	RS599	3/7/2001	unpaved	4.6 4.6 4.6	0.3 0.3 0.3	30.5	1.4 1.4 1.4	4.2	1099 838 1096	3032
ACHD TC Sand	BOISL044	RS598	3/8/01	De-icing grab sample	N/A	N/A	N/A	N/A	N/A	2394	2394

Table 2-2 Summer 2001 Silt Sampling Locations, Descriptions, and Mass Sampled

Site	Field Sample ID	Lab ID	Sample Date	Type	Width (m)	Length (m)	Separation Between Sampling Locations (m)	Area per sampling location (m^2)	Total area for site (m^2)	Net Mass per sampling location (g)	Total mass for site (g)
Riva Ridge North of Reutzel Dr.	BOISL028 BOISL029 BOISL030	RS622	7/12/2001	paved	3.9 4.2 4.1	3.1 3.0 3.0	15.2	12.1 12.6 12.5	37.2	1064.5 402 178	1645
Apple St. Between Wright and LaFayette	BOISL053 BOISL054 BOISL055	RS623	7/13/2001	paved	3.3 3.3 3.3	3.0 3.0 3.0	15.2	10.1 10.1 10.0	30.2	19 24.7 38	82
13th St. North of Hays	BOISL045 BOISL046 BOISL047	RS624	7/13/2001	paved	2.4 2.4 2.7	9.1 9.1 9.1	6.1	22.3 22.3 25.1	69.7	58 58.5 109	226
Front St. Between 3rd and 5th	BOISL061 BOISL062 BOISL063	RS625	7/14/2001	paved	3.8 3.8 4.0	6.1 6.1 6.1	12.2	23.4 23.4 24.5	71.2	80 110 123.5	314
West Park Dr. West of Milwaukee	BOISL050 BOISL051 BOISL052	RS626	7/14/2001	paved	2.6 2.7 2.8	6.1 6.1 6.1	9.1	16.1 16.4 17.0	49.5	27 16.5 10.5	54
Maple Grove North of Tillamook	BOISL031 BOISL032 BOISL033	RS627	7/12/2001	paved	3.4 3.4 3.4	9.1 9.1 9.1	12.2	30.7 30.9 31.1	92.7	32.5 52 51	136
Garrity Blvd. Between Cavalry and 11th	BOISL067 BOISL068 BOISL069	RS628	7/17/2001	paved	3.6 3.6 3.5	9.1 9.1 9.1	6.1	32.5 33.0 31.8	97.3	144.5 251.5 142.5	539
Amity Between Colorado and Diamond	BOISL064 BOISL065 BOISL066	RS629	7/17/2001	paved	3.9 4.0 3.9	3.0 3.2 3.0	12.2	11.8 13.0 11.8	36.7	75.5 73.5 71	220
6th St. Between 6th Avenue and 7th Ave	BOISL070 BOISL071 BOISL072	RS630	7/17/2001	paved	3.0 3.0 3.0	0.3 0.3 0.3	6.1	0.9 0.9 0.9	2.8	550.5 331.5 273	1155
Pierce Park	BOISL073 BOISL074 BOISL075	RS631	7/25/2001	unpaved	4.6 4.6 4.6	0.3 0.3 0.3	45.7	1.4 1.4 1.4	4.2		7200
Cloverdale Farm Road	BOISL076 BOISL077 BOISL078	RS632	7/26/2001	unpaved	4.6 4.6 4.6	0.3 0.3 0.3	30.5	1.4 1.4 1.4	4.2		1975
Road Near Lucky Peak Dam	BOISL079 BOISL080 BOISL081	RS633	7/25/2001	unpaved	4.6 4.6 4.6	0.3 0.3 0.3	30.5	1.4 1.4 1.4	4.2		3135

Procurement of silt samples from paved roads requires that the road surface is initially broom-swept to remove large debris such as pebbles and plant material. All of the road sections sampled were free of large debris, which made broom-sweeping unnecessary. For each road section, a pre-labeled, pre-weighed HEPA vacuum bag was installed in a backpack style vacuum cleaner. The attachment used at the end of the vacuum cleaner hose was 4.2 cm by 23 cm in dimension. Each section was completely vacuumed twice (once in the widthwise direction and once in the lengthwise direction) by traversing the section in overlapping strips from one edge to the other. Vacuum bags were weighed on-site after vacuuming and placed in airtight plastic bags.

Unpaved roads were sampled by gently passing a hand-held broom across the lane of travel and collecting the swept material in a lobby pan. At each site, three sections of road, separated by 30 m to 45 m were sampled. Sections were generally 1 ft in the along-lane direction by 4.6 m in the cross-lane direction. Debris and dirt from parts of the road that were outside the travel lane were not included in the sample.

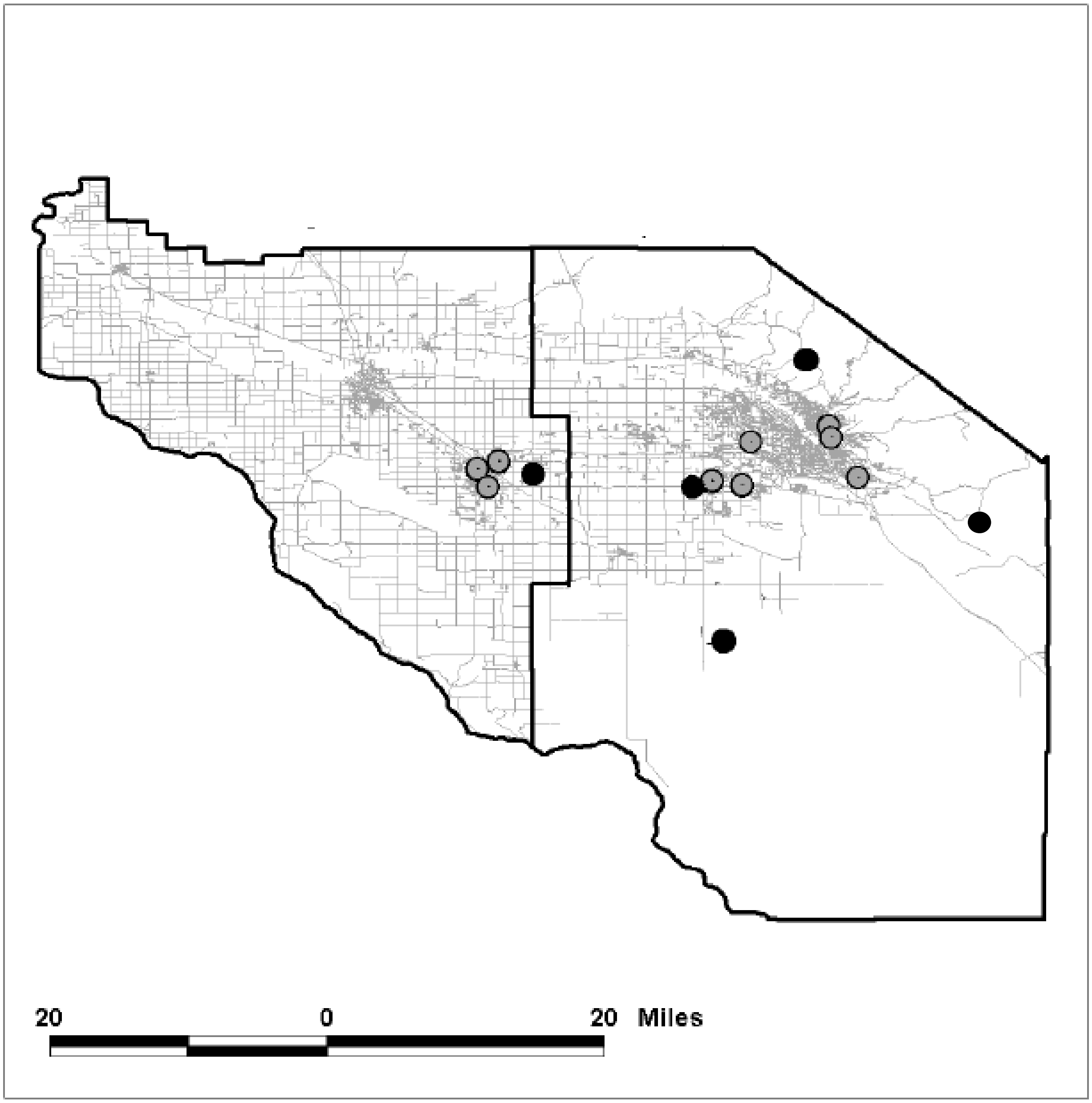


Figure 2-1. Map of Sample Collection Locations. Gray circles indicate paved road dust silt sampling. Black circles are locations where unpaved road dust was collected.

Silt analysis was performed on a per site basis. That is, the three samples for a given site were consolidated before silt analysis. The silt fraction of a sample was obtained by mechanical sieving as outlined in Appendix C.

2.2 Results

Silt loading and silt content results for winter 2001 samples from Ada and Canyon Counties are summarized in Table 2-3 and Table 2-4; similar data from summer 2001 are shown in Table 2-5 and Table 2-6. Detailed silt data on a site-by-site basis are given in Appendix C.

Table 2-3. Silt Content and Silt Loading from Winter Road Samples in Ada and Canyon Counties

Location	County	Road Type	Sample Date	Area (m^2)	Sample Weight (g)	Silt (g)	Silt content (%)	Silt Loading (g/m^2)
Front St. Between 3rd and 5th	Ada	Arterial	3/4/2001	71.2	907	169	22	2.8
Maple Grove North of Tillamook	Ada	Arterial	3/6/2001	92.7	554	151	36	2.1
Garrity Blvd. Between Cavalry and 11th	Canyon	Arterial	3/7/2001	97.3	977	79	9.0	0.9
Riva Ridge North of Reutzel Dr.	Ada	Collector	3/1/2001	37.2	2601	24	0.9	0.7
13th St. North of Hays	Ada	Collector	3/4/2001	69.7	521	73	18	1.3
Amity Between Colorado and Diamond	Canyon	Collector	3/7/2001	36.7	602	180	40	6.6
Apple St. Between Wright and LaFayette	Ada	Local	3/3/2001	30.2	619	114	23	4.7
West Park Dr. West of Milwaukee	Ada	Local	3/6/2001	49.5	709	56	9.5	1.4
6th St. Between 6th Avenue and 7th Ave	Canyon	Local	3/7/2001	63.2	4342	181	8.6	5.9
Howry	Ada	Unpaved	3/6/2001	4.2	3823	43	1.1	
Cloverdale Farm Road	Ada	Unpaved	3/17/2001	4.2	1595	33	2.1	
Pierce Park	Ada	Unpaved	3/16/2001	4.2	969	7.7	0.8	
Unpaved Driveway Off Happy Valley	Canyon	Unpaved	3/7/2001	4.2	1447	23	1.6	
Ada County Highway District	Ada	De-icing Material, TC Sand	3/8/2001	N/A	2213	6.5	0.3	

Table 2-4. Summary of Winter Silt Measurements by County

Road Type	County	Average Silt %	Standard Deviation Silt %	Average Silt Loading (g/m^2)	Standard Deviation Silt Loading (g/m^2)
Arterial	Ada	29	9.7	2.5	0.5
Arterial	Canyon	9.0	N/A	0.9	N/A
Arterial	Ada & Canyon	22	13	1.9	1.0
Collector	Ada	9.3	12	1.0	0.5
Collector	Canyon	40	N/A	6.6	N/A
Collector	Ada & Canyon	20	20	2.9	3.3
Local	Ada	16	9.4	3.0	2.4
Local	Canyon	8.6	N/A	5.9	N/A
Local	Ada & Canyon	14	8.0	4.0	2.3
Unpaved	Ada	1.3	0.7	N/A	N/A
Unpaved	Canyon	1.6	N/A	N/A	N/A
Unpaved	Ada & Canyon	1.4	0.6		

Table 2-5 Silt Content and Silt Loading from Summer Road Samples in Ada and Canyon Counties

Location	County	Road Type	Sample Date	Area (m^2)	Sample Weight (g)	Silt (g)	Silt (%)	Silt Loading (g/m^2)
Front St. Between 3rd and 5th	Ada	Arterial	7/14/2001	71.2	314	27	9	0.4
Maple Grove North of Tillamook	Ada	Arterial	7/12/2001	92.7	136	32	24	0.3
Garrity Blvd. Between Cavalry and 11th	Canyon	Arterial	7/17/2001	97.3	539	81	15.1	0.8
Riva Ridge North of Reutzel Dr.	Ada	Collector	7/12/2001	37.2	1645	37	2.2	1.0
13th St. North of Hays	Ada	Collector	7/13/2001	69.7	226	33	15	0.5
Amity Between Colorado and Diamond	Canyon	Collector	7/17/2001	36.7	220	24	11	0.7
Apple St. Between Wright and LaFayette	Ada	Local	7/13/2001	30.2	82	19	23	0.6
West Park Dr. West of Milwaukee	Ada	Local	7/14/2001	49.5	54	8	14.0	0.2
6th St. Between 6th Avenue and 7th Ave	Canyon	Local	7/17/2001	2.8	1155	14	1.2	5.0
Cloverdale Farm Road	Ada	Unpaved	7/26/2001	4.2	1975	81	4.1	
Pierce Park	Ada	Unpaved	7/25/2001	4.2	1796	27	1.5	
Road Near Lucky Peak Dam	Canyon	Unpaved	7/25/2001	4.2	1612	77	4.8	

Table 2-6 Summary of Summer Silt Measurements by County

Road Type	County	Average Silt %	Standard Deviation Silt %	Average Silt Loading (g/m^2)	Standard Deviation Silt Loading (g/m^2)
Arterial	Ada	16	10.6	0.4	0.0
Arterial	Canyon	15.1	N/A	0.8	N/A
Arterial	Ada & Canyon	16	8	0.5	0.3
Collector	Ada	8.5	9	0.7	0.4
Collector	Canyon	11	N/A	0.7	N/A
Collector	Ada & Canyon	9	6	0.7	0.3
Local	Ada	19	6.5	0.4	0.3
Local	Canyon	1.2[a]	N/A	5.0[a]	N/A
Local	Ada & Canyon	19[a]	6.5[a]	0.4[a]	0.3[a]
Unpaved	Ada	3.5	1.7	N/A	N/A
Unpaved	Canyon	N/A[b]	N/A[b]	N/A	N/A
Unpaved	Ada & Canyon	3.5[b]	1.7[b]	N/A	N/A

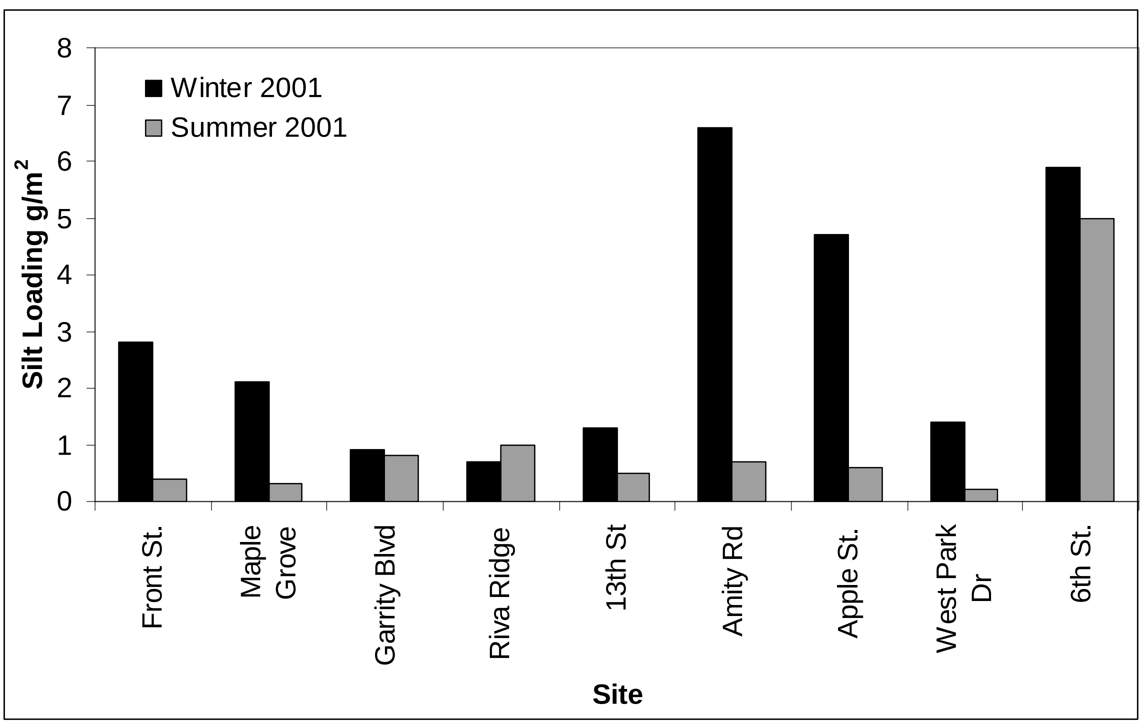
[a] Sampling of the "Local" road from Canyon County occurred when pre-treatment for chip-sealing was in place. Dusty gravel covered the road surface. This sample is not included in the average value for Ada and Canyon Counties since it is not representative of road conditions.

[b] No samples of unpaved road dirt were procured from Canyon County during the summer 2001 sampling season only. The average for Ada and Canyon Counties has ben computed based on three samples from Ada County

For the winter samples, silt loading on paved roads ranged from 0.7 g/m^2 at the Riva Ridge site to 6.6 g/m^2 at Amity Road. Silt loadings by roadway classification for both Ada and Canyon Counties averaged 1.9, 2.9, and 4.0 g/m^2 for arterial, collector, and local roads respectively. This is consistent with the expectation that roads with higher Vehicle Kilometers Traveled (VKT) and travel speeds are likely to have lower loadings than less frequently-used roads.

Silt loadings in the summer were substantially lower than winter. Summer values ranged from 0.2 g/m^2 (West Park Dr.) to 1.0 g/m^2 (Riva Ridge). Note that the silt loading on 6th St was 5.0 g/m^2. However, that sample was collected when the street was covered with gravel chips as part of the summer chip-sealing program; this sample can be used to estimate road dust emissions under chip-sealing conditions, but should not be included in calculating seasonal or countywide averages. Summer silt loadings by roadway classification were 0.5, 0.7, and 0.4 g/m^2 for arterial, collector, and local roads, respectively. These values are approximately four to ten times lower than winter silt loadings. Figure 2-2 shows comparisons between winter and summer 2001 silt loadings by site. Of the nine sites, only Garrity Blvd, an arterial, and Riva Ridge, a local road, had comparable values between summer and winter. 6th St silt loadings were also similar between the two seasons, though, the summer 6th St sample is not representative due to the influence from chip-sealing activities.

Figure 2-2. Comparison of Winter and Summer 2001 Silt Loadings. Summer 2001 6th St sample influenced by chip-sealing operations.



Silt loadings from the present study are compared to the values used to prepare the 1995 emissions inventory (SAI, 1997) in Table 2-7. Silt loading values used in the 1995 emissions inventory were based on average and wintertime default values specified by AP-42 (USEPA, 1995). Compared to the default wintertime values used to compile the 1995 emissions inventory, silt loadings measured in winter 2001 were higher for arterial and local roads and comparable for collectors. In contrast, summer silt samples were comparable with the SAI inventory for arterials, but much lower for collectors (0.7 g/m^2 vs 2.5 g/m^2) and local roads (0.4 g/m^2 vs 2.5 g/m^2).

Table 2-7. Comparison of 2001 Silt Measurements and Values Used for 1995 Emissions Inventory

Road Type	Average Silt Loading for Winter 2001 (g/m^2)	Average Silt Loading for Summer 2001 (g/m^2)	Wintertime silt Loading Used for 1995 EI (g/m^2)	Average Silt Loading Used for 1995 EI (g/m^2)
Freeway			0.02	0.02
Arterial	1.9	0.5	0.5	0.4
Collector	2.9	0.7	3	2.5
Local	4.0	0.4	3	2.5
Road Type	**Average Silt Content for Winter 2001 (%)**	**Average Silt Content for Summer 2001 (%)**	**Average Silt Content Used for 1995 EI (%)**	
Unpaved	1.4	3.5	5.7	

Silt contents from unpaved roads ranged from 0.8% at Pierce Park Drive to 2.1% at Cloverdale Farm Road with an average value of 1.4% for winter samples. For summer samples, they ranged from 1.5% at Pierce Park Drive to 4.8% at an access road near Lucky Peak Dam, with an average value of 3.1 %. The default value of silt content used in the 1995 emissions inventory was 5.7% for both “average daily” and “winter travel” conditions. It is interesting that the silt contents for both Pierce Park Drive and Cloverdale farm road seem to be higher in the summer than the winter. This is due, at least in part, to uncertainties that are inherent in the measurement. Some of the differences between summer and winter may also be due to meteorological conditions. Perhaps under dry summertime conditions, the fine clays in road dirt are more likely to be present on the surface than in wintertime.

Sand used for de-icing Ada County Roads in the wintertime has a relatively low silt content (0.3%) compared to samples obtained from paved and unpaved roads (Table 2-3). This is not surprising since the type of sand used for this purpose was selected for its low dust content.

3. TRAKER OPERATION

The Treasure Valley Road Dust Study (TVRDS) makes extensive use of the TRAKER road dust emissions measurement system. In this Chapter, we discuss the TRAKER measurement method, the results of several quality assurance tests, and the derivation of a calibration curve that directly relates values measured by the TRAKER to PM_{10} road dust emissions.

3.1 Description of the TRAKER concept

The principle of operation of the TRAKER (Testing Re-entrained Aerosol Kinetic Emissions from Roads) is illustrated in Figure 3-1. The concentration of airborne particles is monitored through inlets that are mounted near the front tires of a vehicle. These particle sensors are influenced by the road dust generated from the spinning of the tire. A background measurement of particle concentrations is obtained simultaneously at a location on the vehicle far away from the tires. The difference in the signals between the influence monitors and the background monitor is related to the amount of road dust generated:

$$T ? T_T ? T_b \qquad (1)$$

where T is the raw TRAKER signal, T_T is the particle concentration measured behind the tire, and T_B is the background concentration.

The TRAKER system was first used in Las Vegas to survey road dust on over 100 miles of paved roads (Kuhns et al, 1999). The test vehicle consisted of a 1988 Jeep Cherokee outfitted with a GPS system and video camera to document road conditions. Two light scattering instruments (TSI DustTrak model # 8520) measured concentrations of particles with aerodynamic diameter less than 10 ?m (PM_{10}) from samples taken through inlets mounted behind the tire (influence monitor) and on the vehicle hood (background monitor). The data streams from all onboard instruments were collected through a laptop computer.

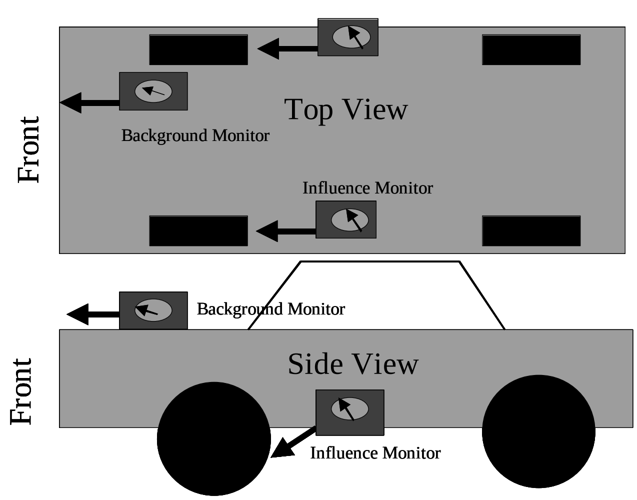


Figure 3-1. Principle of operation of the TRAKER. Influence monitors measure the concentration of particles behind the tires. The background monitor is used to establish a baseline

3.2 TRAKER Measurements

For the TVRDS, several improvements have been made over the original test vehicle. In place of a Jeep Cherokee, a 1979 Chevy van is equipped with three exterior steel pipes that act as inlets for the onboard instruments (Figure 3-2a). Two of the pipes are located behind the left and right front tires and are used to measure the emissions from the tires. The third pipe runs along the centerline of the van underneath the body and extends through the front bumper. This pipe is the inlet for background air. Dust and exhaust emissions from other vehicles on the road can cause fluctuations in the particle concentration above the road surface. The background measurement is used to correct the measurements behind the tires for those fluctuations.

The three exterior pipes enter the cargo compartment of the van through the underbody. Each pipe then goes into a plenum/manifold; the plenum distributes the sample air to up to five instruments (Figure 3-2c). Three types of instruments have been used over the course of this study: TSI DustTrak monitors, GRIMM optical particle size analyzers, and filter-based MiniVol samplers.

A central computer collects all the data generated by the onboard instruments (Figure 3-2d). Data from TRAKER measurements are imported into a Microsoft Access database for subsequent data processing and analysis.

3.2.1 Inlets

Unlike gases, particles have inertia; as a result, sampling of particles through an inlet necessarily results in some particle losses to inlet surfaces. These losses could be due to diffusion of particles towards inlet walls or impaction/settling of particles upon inlet walls. Diffusion is a phenomenon that governs the motion of very small particles (less than 0.1?m). Since road dust is comprised primarily of larger particles (greater than 0.3?m), diffusion is not an important consideration for TRAKER. Impaction and gravitational settling can be important processes for particles with aerodynamic diameters greater than 1?m. In general, gravitational settling can be minimized by reducing the amount of time a particle spends in the inlet lines (e.g. by increasing the speed of the flow). On the other hand, particle impaction can be minimized by reducing the speed of the flow turns within the inlet lines.

The inlet lines, visible in Figure 3-2a are 19 mm (3/4”) in diameter and 2.3 m (7.5’) in length for the tire lines and 3.7 m (12’) in length for the background line. The influence inlets on the right and left are in slightly different positions with respect to the tires. On the right, the inlet is 165 mm (6.5”) above the ground, 50 mm (2”) behind the tire, and 63 mm (2.5”) in (towards the center of the vehicle) from the outside edge of the tire. On the left, the inlet is 165 mm (6.5”) above the ground, 63 mm (2.5”) behind the tire, and 63 mm (2.5”) in from the outside edge of the tire. Because of the vehicle configuration, it is not possible to avoid bends in the inlet lines. However, wherever necessary, bends have been kept as shallow as possible in order to minimize losses of particles to the inlet walls. Each of the inlet lines feeds into a 600 mm (20”) long torpedo-shaped plenum (Figure 3-2c). All particle sampling instruments are connected through the plenum via short Tygon tubes that are in turn attached to 200 mm (8”) long steel tubes that extend into the body of the plenum. Flowrates through the inlets are 75 liters per minute (lpm), corresponding to an inlet face velocity of 4 meters per second (mps) and 0.3 mps in the plena.

Figure 3-2. Photographs depicting TRAKER vehicle and instrumentations used in the Treasure Valley Road Dust Study. a. Location of inlets (right side and background shown); b. Generator and pumps are mounted on a platform on the back of the van; c. Photo showing two sampling plenums (bottom), a suite of DustTrak and GRIMM particle monitors (top right), and three rotameters used for ensuring proper flows through plena; d. a dashboard-mounted computer screen is used to view the data stream and a GPS logs the TRAKER's position every 1 second.

3.2.2 Inlet Dilution System

An optional dilution system was developed for operating the TRAKER on unpaved roads where road dust loadings are outside measurement range of the onboard instruments. The dilution system utilizes a second on-board carbon vane pump to provide clean air to the left and right TRAKER inlets. The pump draws in ambient air from the roof of the TRAKER. The air is compressed and forced through a high efficiency filter to remove ambient particles and particles introduced by the carbon vanes inside the pump. Manual valves allow for independent flow control for the left and right dilution lines. The dilution air lines are attached to the inlet pipe via a U-shaped tube that is inserted 1.5 cm into the inlet. A photograph of the inlet line with the dilution attachment is shown in Figure 3-3.

Figure 3-3. Photograph showing inlet configuration of TRAKER dilution system.

3.2.3 Instruments

3.2.3.1 TSI DustTraks

The TSI DustTrak (model # 8520) is a rugged portable monitor that uses particle light scattering to infer PM concentrations. The instrument is calibrated using NIST Arizona Dust to relate light scattering intensity to aerosol mass concentrations in mg/m^3. The DustTrak measures aerosol mass over a range of concentrations from 0.001 mg/m^3 to 150 mg/m^3 at a frequency of 1 Hz. (Note: 1 mg/m^3 = 1000?? g/m^3). The instrument is shipped from the manufacturer with three impactor inlets to remove particles greater than 10 ?m, 2.5 ?m, and 1 ?m. The flowrate at the instrument inlet is 1.7 lpm.

In this study, six DustTraks were used onboard the TRAKER. Each of the three plena (left, right, and background) was equipped with two DustTraks, one with a 10 ?m inlet and the other with a 2.5 ?m inlet. For three days during the winter field campaign (3/6/01, 3/10/01, and 3/15/01) no measurements were obtained from the right side of the vehicle due to a shortage of operational instruments.

3.2.3.2 Grimm 1.108 Particle Size Analyzer

The Grimm 1.108 Particle Size Analyzer (PSA) provides real-time size-segregated particle counts for particles in 15 different size bins that span the range from 0.3 - 20 ?m. The PSA uses the light scattering properties of a particle to estimate its physical size. The particle size number distribution can be converted to a mass distribution using an assumed or inferred particle density. The flowrate at the instrument inlet is 1.8 lpm.

In this study, the PSAs were used to supplement the DustTraks. During the winter portion of the study (starting on 3/3/01), two PSAs were utilized; one was connected to the left inlet and the other to the background inlet. A third PSA was added to the right inlet for the summer portion of the field study.

3.2.3.3 Ashtech Promark GPS

The global positioning system provides a highly accurate method of obtaining real-time position information. A mobile GPS unit consists of a portable device that receives signals broadcast by at least four different satellites. The satellites broadcast time signals that are used by the mobile unit to triangulate a three dimensional location.

Due to correctable interferences such as clock, ephemeris, ionospheric, and tropospheric errors, the accuracy of the raw GPS signal is approximately 15 m. This accuracy can be improved to within 3-4 m by a post-processing scheme known as differential processing. In this scheme, a GPS is situated at a station with a known position that is in the approximate vicinity of the mobile unit. By comparing the known coordinates of the station with the coordinates reported by the GPS, it is possible to achieve an accuracy of a few meters with a handheld mobile device. Data for stationary GPS are readily available on the Internet for the purpose of applying differential correction.

All data obtained from the mobile GPS used in the Treasure Valley Road Dust Study were differentially corrected against a stationary GPS located at Burns, Oregon.

3.2.3.4 Airmetrics MiniVol

The Airmetrics MiniVol is a portable filter-based sampler. The battery-operated device is equipped with an air pump, internal flow regulator, and a timer/controller. A pneumatic attachment at the top of the unit is used to connect the MiniVol controller to a filterpack. The filterpack consists of a number of sequentially staged filters (up to three in a row) and a size-selective inlet.

In this study, six MiniVol samplers were used simultaneously to obtain samples of road dust from within the plena in the TRAKER. Filter samples obtained through use of the MiniVol were analyzed for chemical content. These samples served as an alternate approach for obtaining road dust source profiles. The traditional approach involves resuspending a portion of dirt vacuumed from the road in a specially designed chamber and collecting resuspended particles on filters through appropriate size-selective inlets.

3.2.4 Data Acquisition and Measurement Documentation

The TRAKER uses a central onboard computer to log all real-time data and to provide a means for documenting road conditions.

3.2.4.1 Data Acquisition

The TRAKER may utilize up to 10 instruments (6 DustTraks, 3 PSAs, and a GPS), each generating data at a rate of up to 60 readings per minute. A central onboard computer is used to capture the data in real-time as it is generated. Data from individual instruments are transferred via RS-232 serial interfaces to a multiplexing unit that is in turn connected to the computer. Specialized software has been written to capture the data, use the computer clock to provide a common time stamp, write to a database in real-time, and provide the operator(s) with feedback regarding the status of instruments. An example of the TRAKER display panel is shown in Figure 3-4.

The data capture software was not available for use during the winter portion of the study. Data generated from onboard instruments were captured using the dataloggers that are built into individual instruments. Data were then periodically downloaded to the central computer manually. The TRAKER control panel was available for the entire summer field study.

3.2.4.2 Real-Time Measurement Documentation

In addition to collecting data from onboard instruments, the TRAKER central computer also provides a means to document road conditions. An example of the automated form used to document TRAKER measurements is given in Figure 3-5. The characterization of road conditions is achieved through a set of "Hot Keys" on the keyboard. Provisions have been made for "medium duration" conditions (such as the type of road shoulder and the lane of travel) and "short duration" conditions (such as passing a construction area or an intersection with an unpaved road). Road conditions are automatically written to a database with a computer time stamp, allowing for cross-referencing with the TRAKER measurement. The TRAKER documenter was used in the Treasure Valley Road Dust Study on an experimental basis only.

3.3 TRAKER QA

In this section, we discuss the procedures used to characterize the TRAKER measurement, accuracy, and response to various conditions. We describe the measurement range and precision of the TRAKER, the loss of particles in the inlet sample line, the effect of diluting the sample stream in the inlets, and the effect of vehicle speed on the TRAKER signal.

3.3.1 Measurement Range, Precision, and Out of Range Data

The DustTrak instrumentation onboard the TRAKER vehicle has a precision of 1?g/m^3. Thus, the smallest measurable difference in concentration between the tire and the background monitors is 1 ?g/m^3. As described in Section 3.5, this corresponds approximately to a single point minimum detection limit equivalent to an emissions factor of 0.9 g/VKT, meaning that any 1-second measurement can only be resolved to within this value. Note that substantially smaller emissions factors can be measured with the TRAKER if multiple points are used to calculate an average. At the other end of the measurement range, DustTrak readings above 150 mg/m^3 are not reliable. This corresponds to an emissions factor for PM_{10} of approximately 50 g/VKT. Note that the upper end of the range can be extended to 110 g/VKT if the optional dilution system is in use (Section 3.2.2). This upper limit can be further extended to 160 g/VKT if the ratio of $PM_{2.5}$ to PM_{10} DustTrak measurements is utilized (see section3.3.1.1).

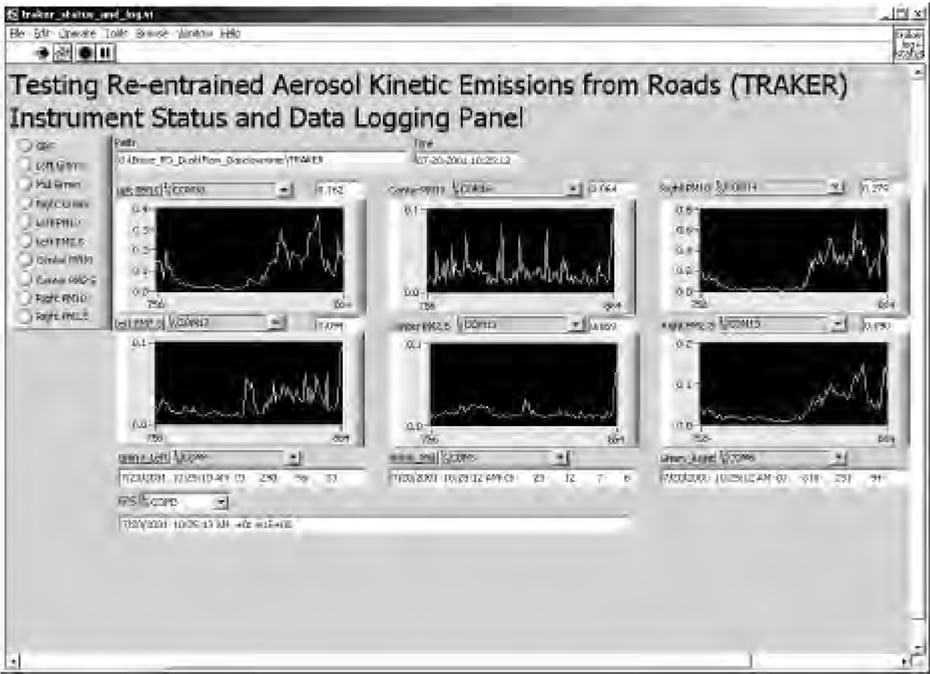


Figure 3-4. TRAKER Control Panel. Real-time figures show the magnitude of the response of DustTraks. Additional displays show measurements from 3 GRIMM particle size analyzers and a global positioning sytem (GPS) receiver. The 10 lights in the top left of the screen serve as indicators of the health of onboard instruments (green = OK; red = not functioning).

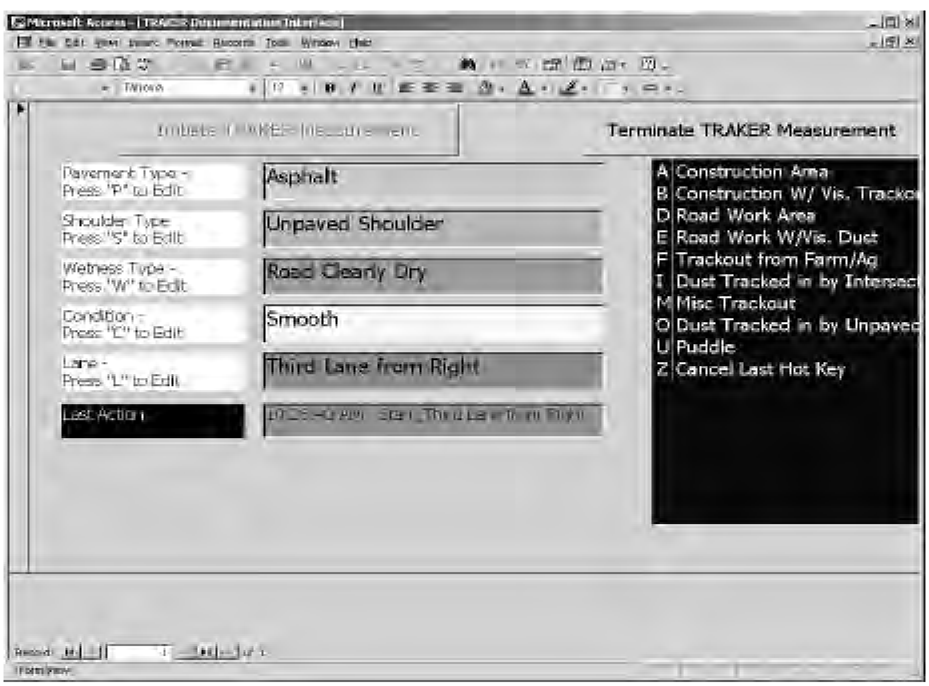


Figure 3-5. TRAKER Measurement Documentation Panel. A series of "hotkeys" are used to assign values to road condition parameters. Parameters are divided into "medium duration" (such as the type of road shoulder and the lane of travel) and "short duration" (such as passing a construction area or an intersection with an unpaved road).

Figure 3-6 shows the TRAKER coefficient of variation for the left and right PM_{10} DustTrak signals as a function of the vehicle speed. The coefficient of variation is a measure of the relative precision and is equal to the standard deviation of the measurement divided by the average of the measurement. In the Figure, the measurement corresponds to multiple passes on the same 1-mile stretch of road in the Treasure Valley. The Figure clearly shows that the precision of the measurement improves with increasing vehicle speed. The precision is 84% at 5 mps, 30% at 9 mps, and approximately 10% above 14 mps. Note that most TRAKER measurements occur at speeds greater than 9 mps (approximately 20 mph). The poor precision at low speeds is probably due to the influence of fluctuating ambient winds on the flow regime behind the front tires. As the vehicle speed increases, such fluctuations become less important compared to the speed of the vehicle (see section 3.3.4 for discussion of the relationship between the TRAKER signal and vehicle speed). The equivalent information for $PM_{2.5}$ DustTraks is shown in Figure 3-7. Note that for $PM_{2.5}$, DustTrak data at speeds less than 50 km/hr are below the detection limits of the instruments. The trend of improved precision with higher speeds is similar to the PM_{10} case.

3.3.1.1 Inferring PM_{10} from $PM_{2.5}$

Unpaved roads are by nature much dustier than paved roads. A dilution system was designed for the TRAKER in order to reduce the particle concentration in the TRAKER inlets and allow the DustTrak measurements to remain within the manufacturer's specified operating range. In some cases, the PM_{10} DustTrak upper limit (150 mg/m^3) was exceeded even with the dilution system in operation. For both the Treasure Valley Road Dust Study, and the calibration tests at Ft. Bliss (described in detail in section 3.4) $PM_{2.5}$ DustTraks were collocated with PM_{10} DustTraks in the sampling plena within the TRAKER. Figure 3-8 shows the relationship between collocated $PM_{2.5}$ and PM_{10} DustTraks. Based on the correlation shown in the figure, when the PM_{10} DustTrak was out of range, the $PM_{2.5}$ value was divided by 0.39 in order to estimate the PM_{10} value. Note that while useful for correcting out of range data, the DustTrak is calibrated for PM_{10} and measurements with a 2.5?m inlet only give a nominal value for $PM_{2.5}$.

For a few cases, both the PM_{10} and $PM_{2.5}$ DustTraks were out of range. Under such circumstances, default values of 770 and 280 mg/m^3 were assumed for PM_{10} and $PM_{2.5}$, respectively. This occurrence is rare and applies to less than 0.5% of the unpaved road data.

3.3.1.2 TRAKER Validity Criteria

A TRAKER data point is only considered valid if it meets all of the criteria outlined in Table 3-1. Criteria are applied to the speed, acceleration, deceleration, and the wheel angle of the TRAKER vehicle. If a data point does not meet any one of the criteria, then that data point is flagged as "Invalid" and is not used in any subsequent data processing activities. Note that the TRAKER measurement uses the difference between the particle concentration measured behind the front tire and the concentration measured through the front bumper (see equation 1 in section 3.3.4). Under certain conditions, the concentration at the front bumper may be higher than it is behind the front tire resulting in a negative measurement. Negative values are NOT considered invalid and are retained in the database. It is important to retain negative values so that a systematic bias is not introduced into the dataset.

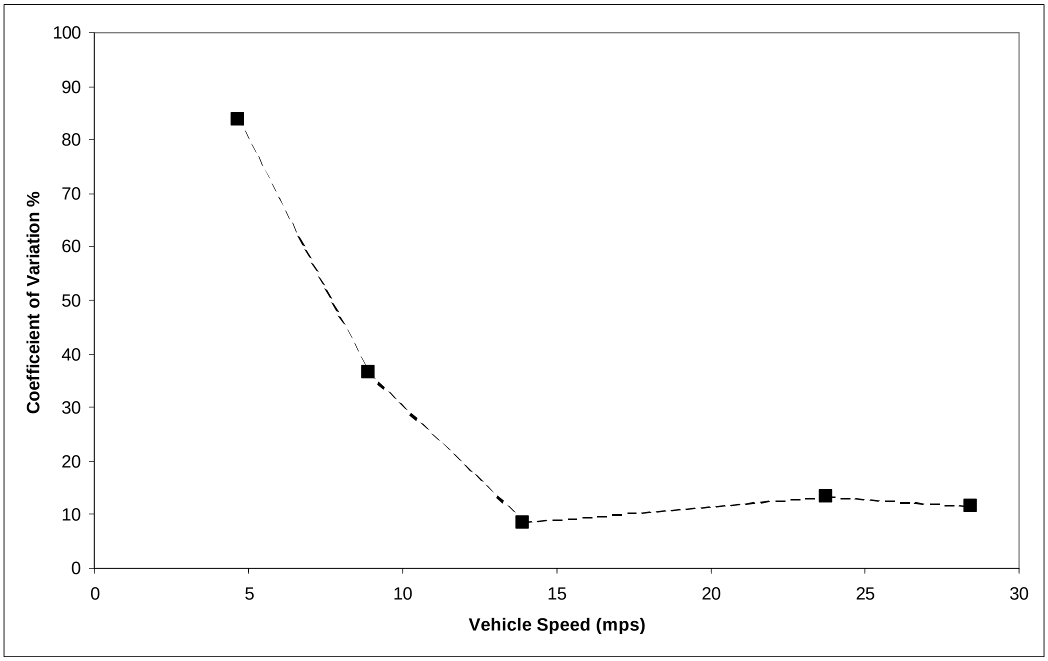


Figure 3-6. TRAKER coefficient of variation expressed as a percentage for left and right PM_{10} DustTrak signals as a function of speed. The data represent left and right PM_{10} DustTrak signals averaged over a 1-mile stretch of road in the Treasure Valley. The coefficient of variation provides an estimate of the precision and is equal to the standard deviation of a measurement divided by the average.

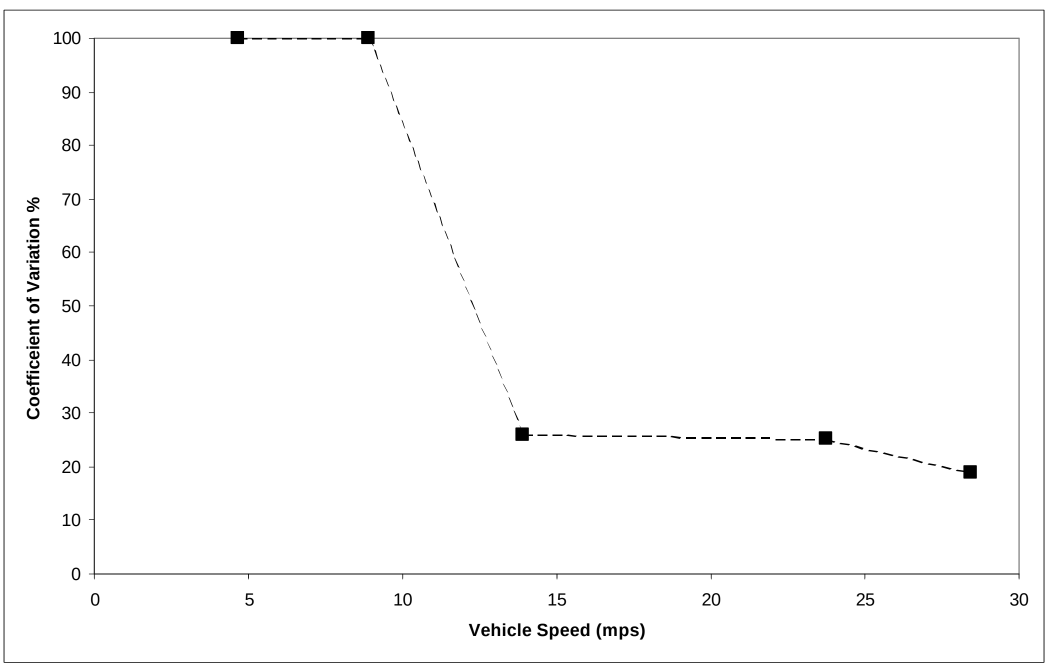


Figure 3-7 TRAKER coefficient of variation expressed as a percentage for left and right $PM_{2.5}$ DustTrak signals as a function of speed. The data represent left and right $PM_{2.5}$ DustTrak signals averaged over a 1-mile stretch of road in the Treasure Valley. The coefficient of variation provides an estimate of the precision and is equal to the standard deviation of a measurement divided by the average. Note that data for speeds less than 50 km/hr are below detection limits for the $PM_{2.5}$ DustTraks.

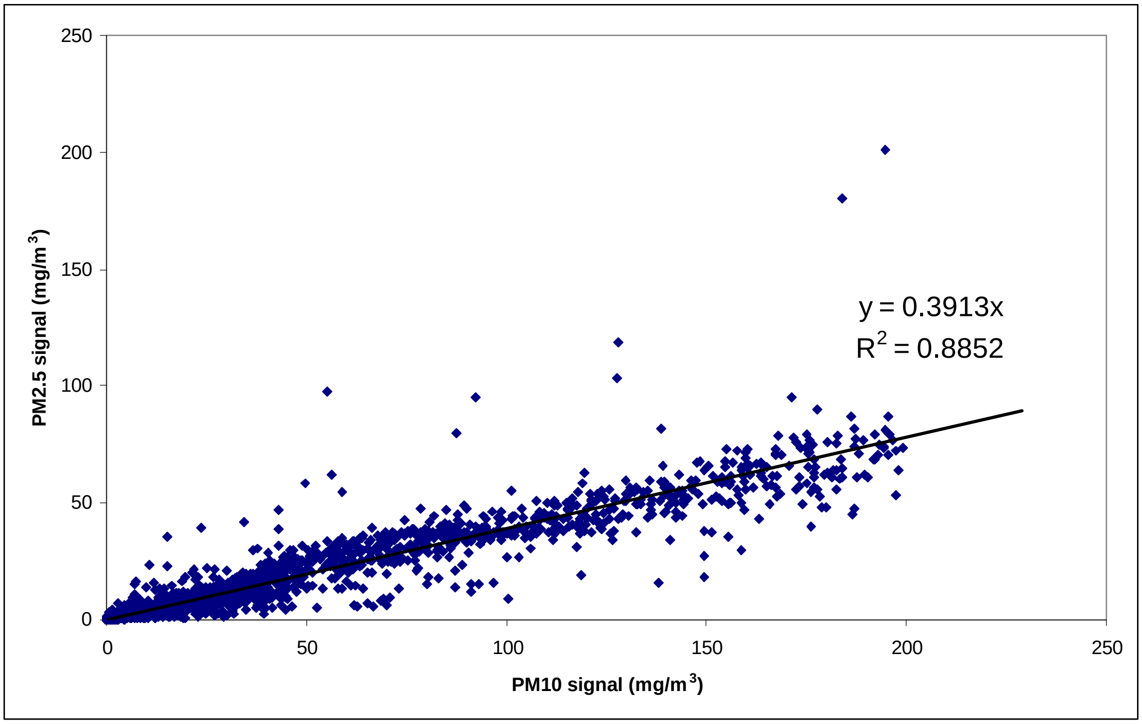


Figure 3-8. PM_{10} and $PM_{2.5}$ DustTrak signals when they are collocated in the same sampling plenum within the TRAKER. An R^2 of 0.89 shows that the two measures are strongly correlated and that on average, the $PM_{2.5}$ value is 39% of the PM_{10} value.

Table 3-1 Validity criteria applied to each 1-second TRAKER data point.

Parameter	Criterion	Threshold	Description
Speed	>	5 m/s – paved roads (~11 miles/hr) 1.5 m/s – unpaved Roads (~3.5 miles/hr)	Minimize disturbances due to ambient winds. Criterion is relaxed for unpaved roads because it is necessary to travel at lower speeds due to high dust emissions that overwhelm the instruments on board the TRAKER.
Acceleration	<	0.5 m/s^2 (~1.1 miles/hr/s)	Lateral shear during acceleration and transient airflow around the TRAKER inlets render TRAKER measurements during times of high acceleration unreliable.
Deceleration	<	0.5 m/s^2 (~1.1 miles/hr/s)	Applying the brakes releases dust particles and may result in false high road dust readings.
Wheel Angle	<	3 degrees with respect to the vehicle body	Turns cause the front wheels to form an angle with the vehicle body. This in turn changes the orientation of the TRAKER inlets with respect to the front tires. Data associated with sharp turns are not valid.

The vehicle speed can become important under conditions of moderate to high winds. If the TRAKER is not moving fast enough, crosswinds and fluctuations in the ambient winds can lead to unsteady flow conditions between the front tire and the inlet. To avoid this possibility, a minimum speed of 5 m/s is required to consider a data point valid. This criterion is relaxed for unpaved roads (1.5 m/s) where traveling at high speeds can cause the DustTraks and PSAs on board the TRAKER to be overwhelmed with high dust concentrations. Acceleration/deceleration criteria (< 0.5 m/s^2) are also applied to the TRAKER measurement. During periods of high acceleration, the flow regime around the inlets may be transient; during periods of deceleration, dust from the brakes may influence the particle concentrations behind the front tire. In addition, the wheel angle must be less than 3 degrees with respect to the vehicle body. This is to ensure that the orientation of the inlets with respect to the front tires is not changing over the course of the measurements. The criteria shown in Table 3-1 are based on empirical observations and statistical analyses of the TRAKER measurement under a variety of driving regimes. They are conservative and intended to ensure that the measurements used in this study are valid.

3.3.2 Inlet Loss

To assess the magnitudes of particle losses in the sample inlet lines, particle concentrations at the inlet were compared to concentrations measured by the instruments attached to the plena. The TRAKER was parked perpendicular to and 15 meters downwind of an unpaved road. Two PSAs were placed within 5 cm of the inlet opening (Figure 3-9). Inside the TRAKER, the manifold was outfitted with the usual suite of instruments, one PSA, one DustTrak with a PM_{10} inlet, and one DustTrak with a $PM_{2.5}$ inlet. Because they have direction-sensitive inlets, and due to their physical configuration, it was not possible to place a DustTrak close enough to the inlet opening for comparison with the measurement inside the TRAKER. Instead, test results for the DustTrak were inferred from the results for the PSA. A second vehicle was driven back and forth on the unpaved road to simulate the particle concentration range that would occur at the inlet during routine operation (Figure 3-10). This test was performed for a minimum of 30 minutes for each of the three inlets. For the inlets behind the left and right front tires, the test was conducted for the normal configuration, as well as for the case where the dilution system was in use. The concentrations measured by each instrument were averaged over the period of the test for inter-comparison purposes.

Figure 3-11 shows the fractional line losses associated with each particle size measured by the PSA for the three inlets. The figure also shows the collocated precision for the PSA. The aerodynamic partide size shown on the x-axis is calculated by assuming that the optical particle diameter is equivalent to the Stokes diameter and that the particles are spherical with a density of 2.6. Based on these assumptions, the aerodynamic diameter is equal to the optical diameter times the square root of the particle density (Seinfeld and Pandis, 1998).

Line losses in the smallest size bin are not consistent with physical expectation and are probably marred by artifacts introduced by instrument error. However, we note that the mass associated with this bin represents less than 0.1% of the mass of PM_{10} and that this error is negligible in the context of the present work. Except for the smallest size bin, there are no significant differences in line losses between the left, right, and background inlets, i.e. differences in line losses between inlets are not greater than twice the precision which is the criterion for deciding whether or not two measurements are significantly different. Thus, the left, background, and right line losses are adequately represented by Figure 3-12 which shows the average line losses for all three inlets. Note that though negative line losses do not have a physical meaning, they are retained in order to correct for inter-instrument biases.

Line losses associated with the DustTrak monitors are also shown in Figure 3-12 for both PM_{10} and $PM_{2.5}$. Data from the PSA tests were used to calculate these line losses since they could not be measured directly. This resulted in an estimated line loss of 5% and 18% for $PM_{2.5}$ and PM_{10} DustTrak measurements, respectively.

Figure 3-9. Photograph showing two GRIMM PSAa and two TSI DustTraks as part of the configuration for the TRAKER background inlet line loss test. Though DustTraks are shown above, the directional nature of the inlets for those instruments did not allow for comparison with DustTraks connected to the plenum inside the TRAKER.

Figure 3-10. Photograph showing dust generation as part of line loss characterization test.

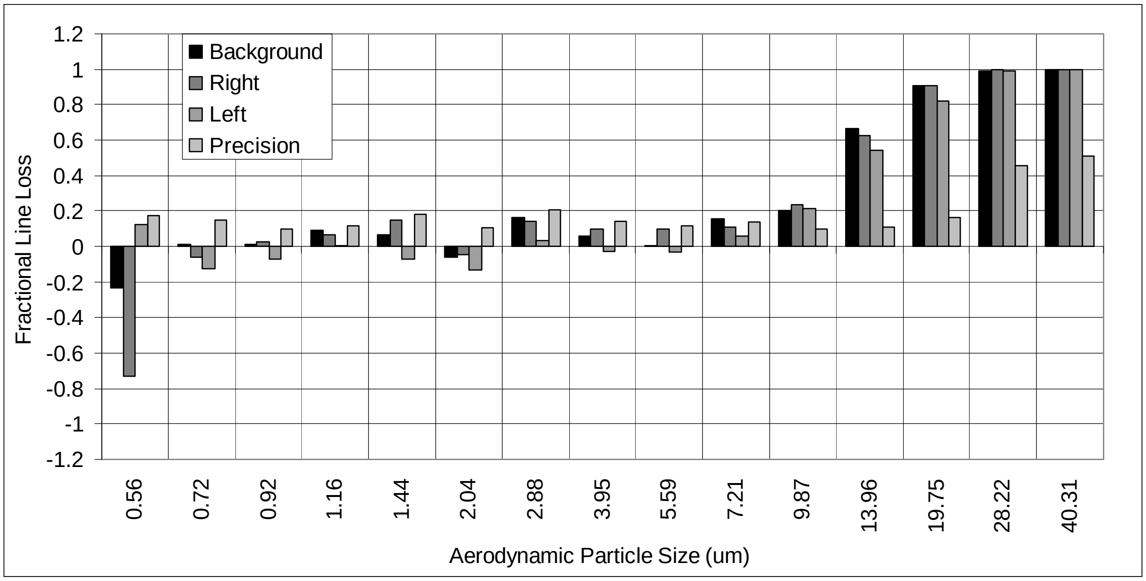


Figure 3-11. Fractional line losses associated with each of the particle sizes measured by the GRIMM PSA and collocated instrument precision for TRAKER right, background, and left inlets.

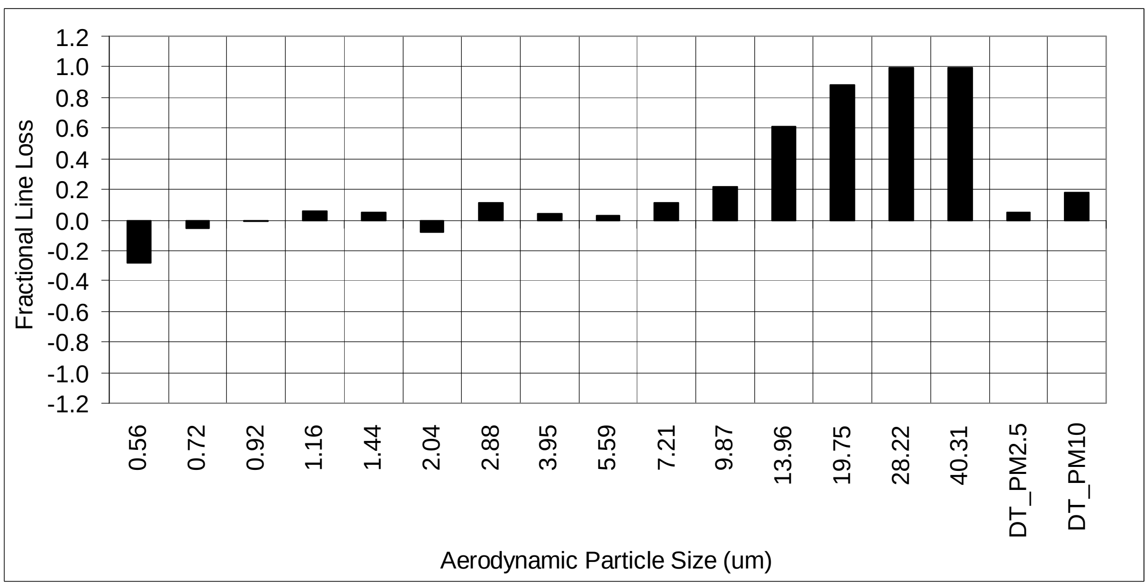


Figure 3-12. Average fractional line loss for left, background, and right TRAKER inlet lines.

3.3.3 Particle Concentration Dilution

Flowrates through the dilution lines were set to approximately achieve ten fold dilution. However, since the rotameters used are temperature and pressure sensitive, actual dilution was determined by performing a line losstest as described in section 3.3.2. Figure 3-13 shows the fractional line losses associated with each particle size bin for the TRAKER inlets when the dilution system is in operation.

As was the case without dilution, there are no consistent differences between the diluted left and right inlets within the limits of measurement uncertainty. Thus, the average shown in Figure 3-14 is used to correct particle concentrations for both inlets.

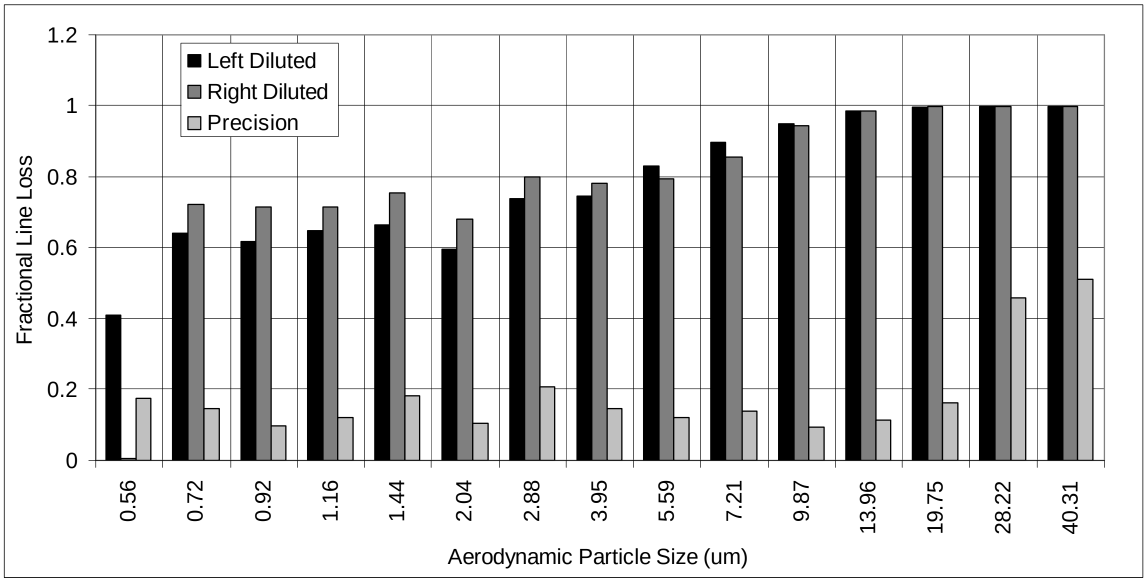


Figure 3-13. Combined dilution and line losses associated with each of the particle sizes measured by the GRIMM PSA and collocated instrument precision for diluted TRAKER right and left inlets.

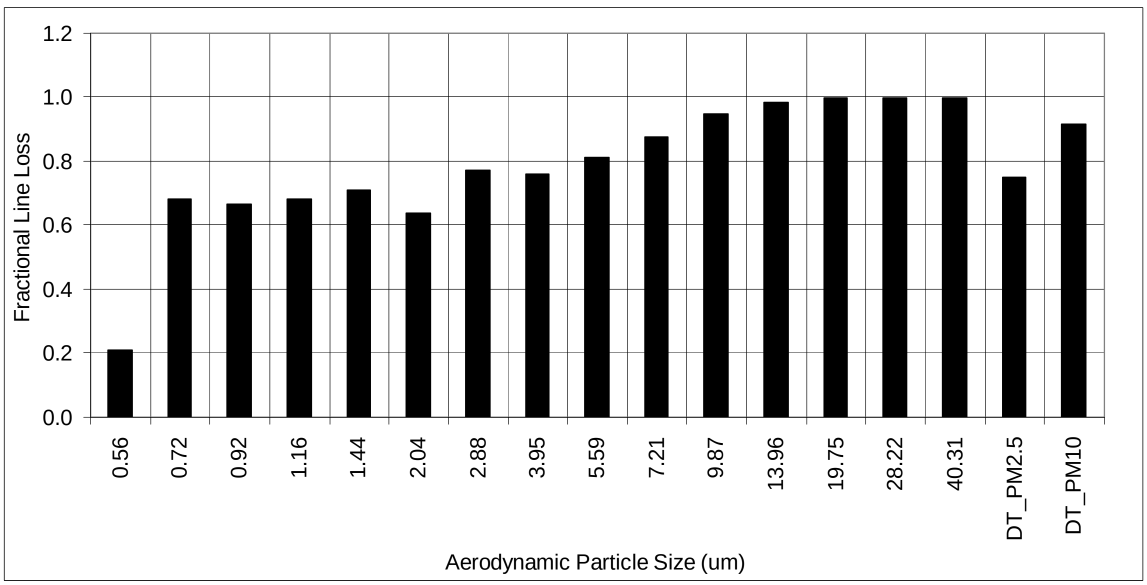


Figure 3-14. Average fractional dilution and line loss for left and right TRAKER inlet lines when dilution system is in use.

3.3.4 Speed Tests

Experiments were conducted to determine the variation of the TRAKER signal with vehicle speed. Tests were conducted on paved roads at the Fort Bliss Military Base near El Paso, Texas and on South Cloverdale Lane in Boise Idaho.

At Fort Bliss, a 1200 m section of road was traveled in the northbound direction. Three passes were run at the speeds (5, 9, 14, 19, 24, and 29 mps or equivalently 10, 20, 30, 40, 50, and 60 mph) for a total of 18 passes. The differential between the tire and the background monitors was averaged over each pass based on the start and stop times of the run. The measurements of

PM_{10} and $PM_{2.5}$ by DustTrak and particle counts per size bin were averaged for the left and right inlets.

In the Treasure Valley, a 440 m section of road was selected for testing. Passes were run over the same range of speeds as in Fort Bliss tests. The same lane of travel was surveyed with the vehicle traveling in both northbound and southbound directions. Using this approach, both the left and right inlets sampled the same tracks on the road. Values were averaged over each pass.

The resulting values from both sets of tests were regressed against the vehicle speed using a power function:

$$T_T \ ? \ T_B \ ? \ T^* s^b \qquad (2)$$

where T_T is the aerosol concentration at the vehicle tire, T_B is the background aerosol concentration at the bumper inlet, and s is the speed of the vehicle. The parameters T^* and b were iteratively calculated by minimizing the least squares error between the observed and predicted values.

Figure 3-15 shows the example of the regression for DustTrak PM_{10} measurements from the Treasure Valley speed tests. In this example, speed explains 97% of the variability of the average measurement from each vehicle pass. The remaining measured parameters (i.e. $PM_{2.5}$, and particle counts for each size bin) were also regressed against vehicle speed. The exponents of these regressions and the percentage of variance explained by the speed term are shown in Table 3-2. Note that T^* in Eq. (2) is a measure of the inherent "dirtiness" of the road.

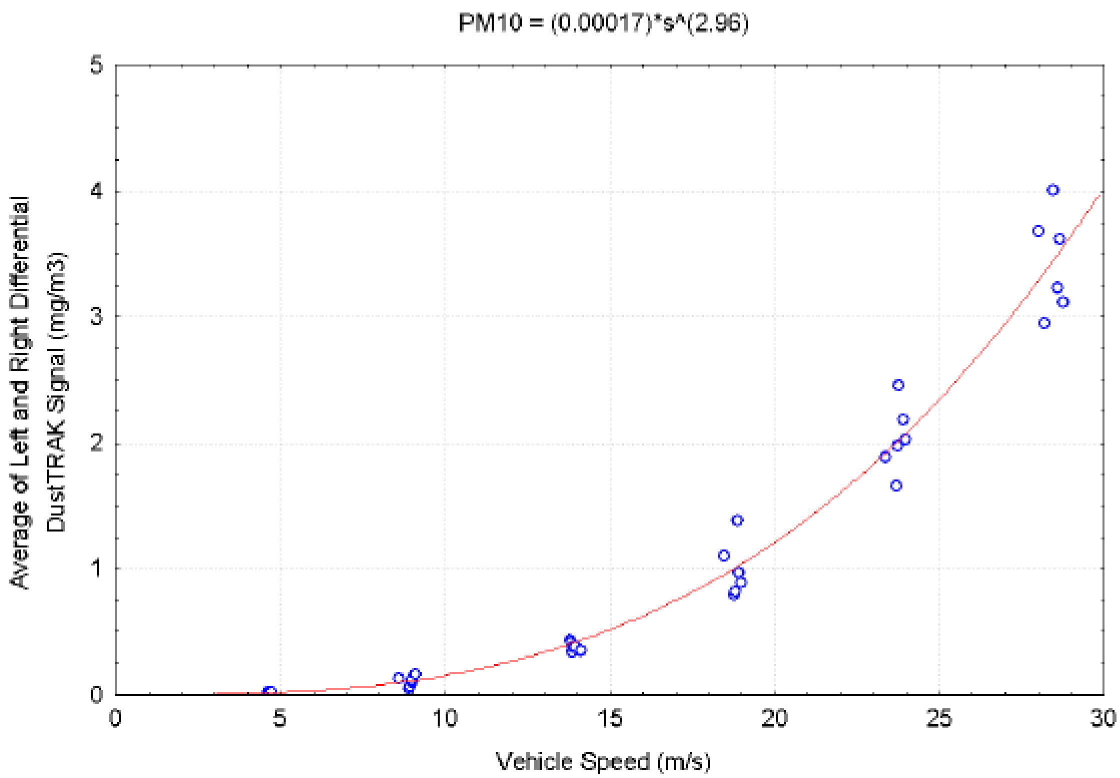


Figure 3-15. Relationship between differential Dustraks measurements and vehicle speed for tests conducted on a common road section in the Treasure Valley, Idaho. R^2 = 0.97.

Table 3-2. Regression exponents for differential TRAKER signal and vehicle speed from tests performed at Ft. Bliss and the Treasure Valley.

Parameter	Ft. Bliss Exponent	Percent Variance Explained	Treasure Valley Exponent	Percent Variance Explained
Dustraks PM_{10} LR	2.75	92.3	2.96	97.2
Dustraks $PM_{2.5}$ LR	3.32	92.6	3.87	93.2
PSA_0.56	3.20	94.5	2.87	85.4
PSA_0.72	3.41	91.1	3.10	87.3
PSA_0.92	3.16	91.9	3.05	88.3
PSA_1.2	3.12	92.3	3.09	90.1
PSA_1.4	3.01	92.6	3.03	91.2
PSA_2	2.99	93.0	2.90	91.8
PSA_2.9	2.81	92.7	2.66	85.0
PSA_4	2.64	93.0	2.95	94.0
PSA_5.6	2.29	92.1	3.18	94.5
PSA_7.2	1.86	90.2	3.04	94.3
PSA_9.9	1.43	83.6	2.76	90.5
PSA_14	1.10	72.5	2.31	91.9
PSA_19.8	0.76	44.8	1.66	78.4

3.4 TRAKER Calibration: Flux Measurements at Ft. Bliss New Mexico

From May 18 through May 24, 2001, unpaved road emissions flux experiments were conducted at the Ft. Bliss Military Base on the Texas/New Mexico Border. The flux measurement portion of the study was funded by the Department of Defense under a SERDP grant to investigate the impacts of military vehicle activities on regional haze. The tests were designed to achieve the following objectives:

?? Measure the rate at which fugitive dust emissions deposit to the desert surface after being emitted.

?? Determine the relationship between unpaved road dust emissions, vehicle speed, and vehicle weight.

?? Calibrate the differential TRAKER signal to measured emissions downwind of the roadway.

The following sections describe the configuration of the experiment and the result of the tests.

3.4.1 Flux Measurement Configuration

The tests described here took place at the M88 Driver Training Range on the Ft. Bliss military facility near El Paso, TX. Three towers were set up at the site, one upwind tower (9 m in high) and two downwind towers (one 9m high and the other 12.2 m high). Figure 3-16 shows a detailed map of the orientation of the flux towers. Historical meteorological data indicated that seasonal winds were predominantly from the west. The towers were aligned so that the upwind tower was 30 m west of the unpaved road and the downwind towers were positioned at 9 m and 50 m downwind of the road. For most days of sampling, wind was from the west to northwest. On May 24, 2001, winds originated from the north. On that day, vehicles were driven on the East-West Test Section so that emissions from the road would pass by the two downwind flux towers. In this configuration the both downwind towers were approximately 30 m from the East-West Test Section.

Each tower was instrumented with four TSI model 8520 DustTraks to measure vertical profiles of particulate matter concentration. The DustTraks were outfitted with a 10 ?m aerodynamic size cut inlet and measured PM_{10} at 1 second intervals throughout the day. Data on the DustTrak monitors were logged on an internal data logger and downloaded to a portable computer at the end of the sampling day.

Grimm model 1.108 particle size analyzers (PSA) were mounted at various positions on the towers to measure changes in the particle size distribution both vertically and with downwind transport. For the majority of the sampling period, one PSA was mounted at 1.25 m AGL on each of the three towers. A fourth PSA was moved to different positions on the towers to measure changes in the particle size distribution at different points in the plume. Data from the PSAs were reported in 6-second intervals and logged onto laptop computers located at the base of each tower.

Five anemometers, one wind vane, and one temperature probe were mounted on the upwind tower to characterize the local meteorological conditions. The meteorological data were recorded on a Campbell 21X data logger and downloaded to a laptop computer at the end of each day. Meteorological data were averaged and stored at 5-minute intervals.

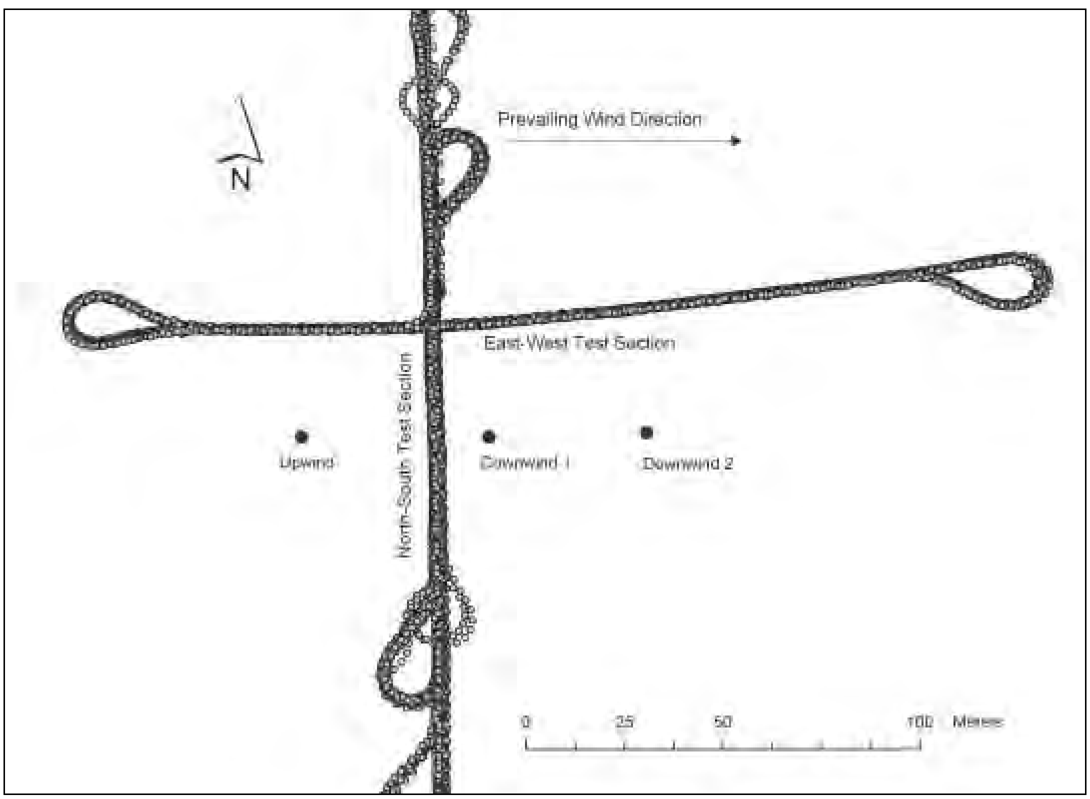


Figure 3-16. Map of upwind-downwind flux measurement towers at Ft. Bliss. The black dots indicate the position of the upwind and downwind towers. The open dots are the GPS points denoting the path of the TRAKER vehicle through the test sections.

3.4.2 Flux Calculation from Meteorological and Particulate Concentrations

Horizontal flux emissions were calculated from the 1-second DustTrak data and the vertical wind profiles measured on the towers. Figure 3-17 shows typical time series of the PM_{10} concentrations measured by the DustTraks at each tower. The concentration spikes in the figure represent individual vehicle passes. The time series are labeled based on the position of the sampler. DW1_2 is the second from the bottom DustTrak on downwind tower 1 (See Figure 3-18 for DustTrak heights). The results of the close downwind tower 1 are shown in the upper panel of the figure while the results from the farther downwind tower 2 are shown in the lower panel.

The figure shows that the concentrations at the close downwind tower typically decrease with height. At the far downwind tower, the second highest sampler typically measures the highest concentrations. More over, the duration of the plume impact on the close tower is approximately 3-7 seconds while the duration at the far tower is 10-15 seconds. These results indicate that the road dust emissions plume is dispersing both vertically and horizontally as the plume moves downwind of the road.

Figure 3-18 shows the vertical distribution of the plume at 9 m and 50 m downwind of the road. Concentrations have been normalized so that they sum to unity. The profile at the far downwind tower clearly shows that the plume is dispersing vertically.

Analysis of the DustTrak data from the three towers indicated that baseline drift over the course of a day did not affect all instruments equally. In order to calculate emissions fluxes from the PM_{10} concentrations, a baseline for each instrument was determined from the peaks shown in Figure 3-17. This baseline concentration was subtracted from the PM_{10} time series so that the resulting concentration time series was due only to the emissions of the vehicle passing the tower.

PM_{10} emissions fluxes were calculated using the assumption that each DustTrak monitor represented a uniform concentration over an interval half way between the monitor and the neighboring monitor on the tower. For example, the lowest monitor on downwind tower 1 (DW1_1) was representative of the PM_{10} concentration from the ground to 1.83 m above ground level (AGL). The second monitor represented the PM_{10} concentrations from 1.83 m AGL to 3.56 m AGL, and so on. The flux of particles at each tower was calculated using the following equation:

$$EF = \cos(\theta) \sum_{i=1}^{4} u_i C_i \Delta z_i \Delta t \qquad (3)$$

where EF is the emissions factor of PM_{10} in grams per vehicle kilometer traveled, θ is the angle between the wind direction and a line perpendicular to the road, i is one of the four positions of the monitors on the tower, u_i is the average wind speed in m/s over the interval represented by the i^{th} monitor, C_i is the average PM_{10} concentration in mg/m^3 as measured by the i^{th} monitor over the interval Δt, Δz in m is the vertical distance represented by the i^{th} monitor, and Δt is the duration that the plume impacts the tower in seconds. A database of the emissions factors was assembled for the parameters: vehicle speed, vehicle type (i.e. Ford Ranger, Chevy Van, HumVee), date, and road orientation (i.e. East-West or North-South). The database is presented in Table 3-3.

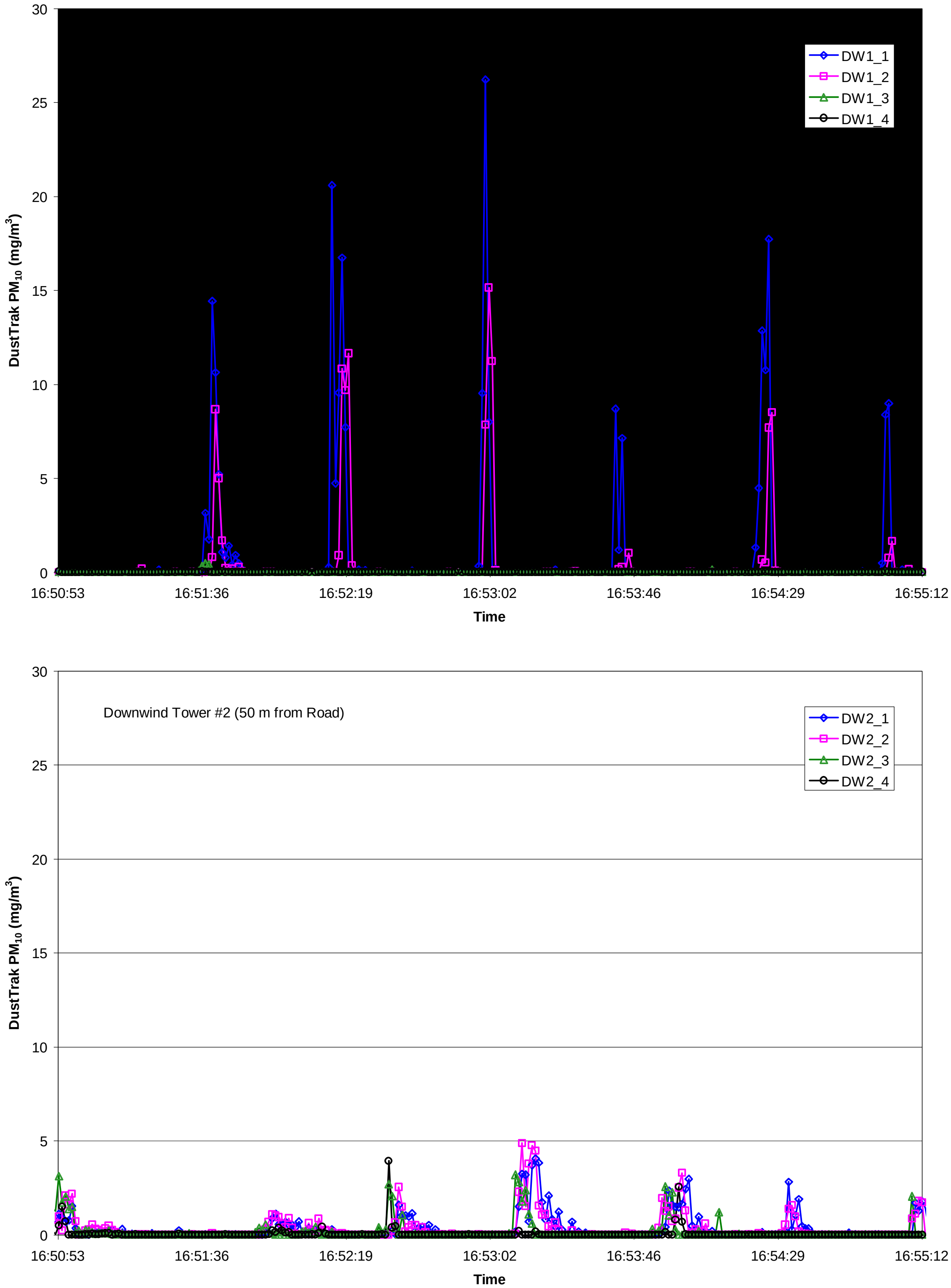


Figure 3-17. Time series plots of concentrations measured on downwind tower #1 (9 m from unpaved road) and downwind tower #2 (50 m from unpaved road).

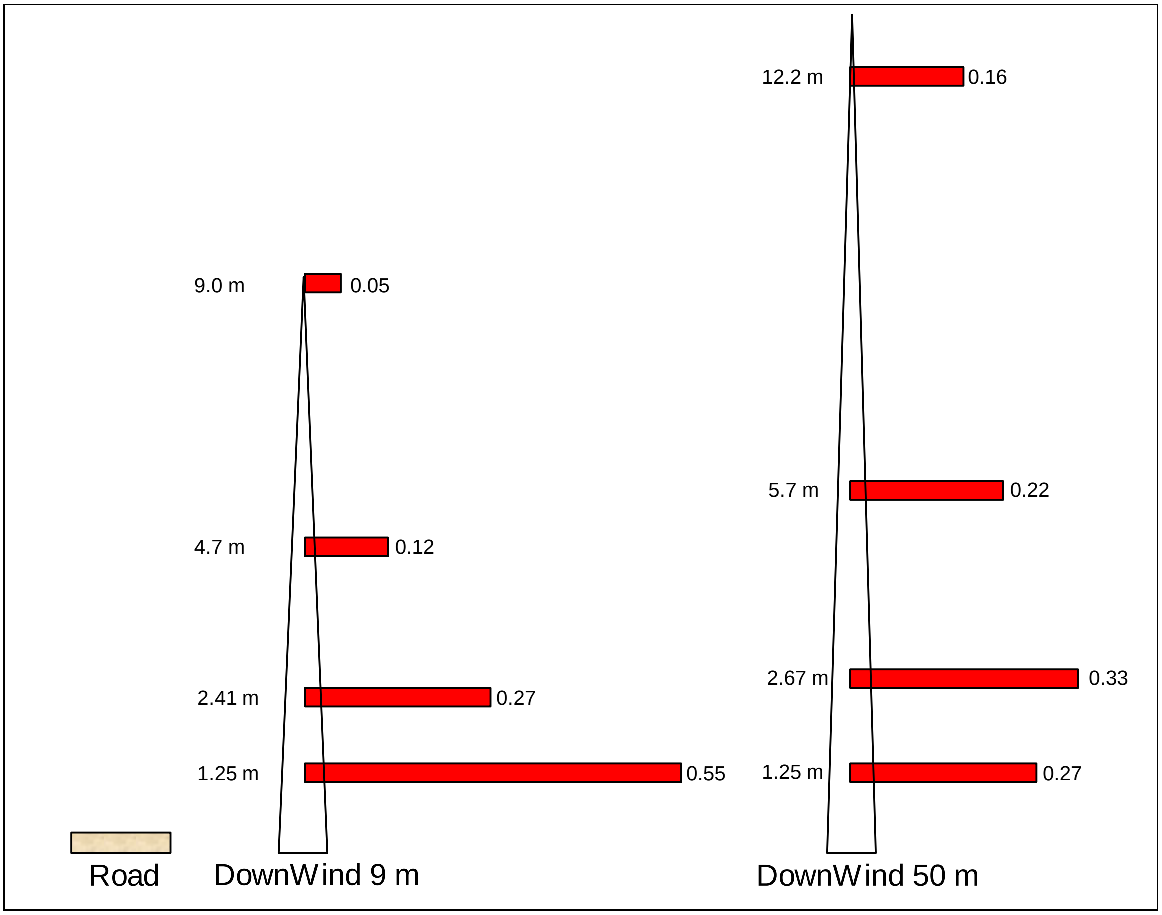


Figure 3-18. Diagram of sampler positions and vertical distribution of the plume downwind of the unpaved road.

For the North-South test section, average emissions factors were calculated from passes of the Ford Ranger and the Chevy Van for a variety of speeds ranging from 14 to 14 mps. At least 10 passes were completed at each speed, allowing for calculation of averages and standard errors of emissions fluxes. Figure 3-19 shows the comparison of the emissions fluxes calculated at the two towers. The regression line relating the two sets of emissions factors has a slope of 1.03 +/- 0.05 and an intercept of –2 +/- 8 g/vkt. This result suggests that the difference of PM_{10} mass flux of particles between the two towers is less than 5% of the total PM_{10} mass flux.

Analysis of emissions factors from the tower experiments indicated that unpaved road dust emissions factors increase with vehicle speed as well as vehicle weight. The Ford Ranger pickup truck has a gross vehicle weight of 1.5 Mg while both theTRAKER vehicle (Chevy Van) and HUMVEE have gross vehicle weights of ~3.5 Mg. Figure 3-20 shows the relationships between emissions factors calculated from towers DW1 and DW2 versus vehicle speed. The Ford Ranger emissions factors have been grouped separately from the TRAKER and HUMVEE emissions factors because of the weight discrepancies. The slope of the regression line for the TRAKER and HUMVEE vehicles is approximately 35% higher than the slope of the Ford Ranger.

Table 3-3. Average emissions factors calculated from unpaved road travel at Fort Bliss.

Test Date	Road Test Section	Vehicle	Target Speed (km/hr)	Number of Vehicle Passes	Emissions Factor on DW1 (g/vkt)	EMFAC DW1 Standard Error (g/vkt)	Emissions Factor on DW2 (g/vkt)	EMFAC DW2 Standard Error (g/vkt)
5/18/01	NS	Ranger	20	16	49	15	53	13
5/18/01	NS	Ranger	30	16	172	47	147	52
5/18/01	NS	Ranger	40	16	308	57	331	66
5/18/01	NS	Ranger	50	15	239	43	242	41
5/18/01	NS	TRAKER	5	10	101	26	41	11
5/18/01	NS	TRAKER	7	15	12	3	17	5
5/18/01	NS	TRAKER	10	18	26	4	28	5
5/18/01	NS	TRAKER	15	3	45	22	36	5
5/20/01	NS	Ranger	20	20			52	19
5/20/01	NS	Ranger	30	20			154	30
5/20/01	NS	Ranger	40	20			234	49
5/20/01	NS	Ranger	50	20			232	38
5/24/01	EW	HUMVEE	10	19	34	9	37	13
5/24/01	EW	HUMVEE	20	20	167	51	161	51
5/24/01	EW	HUMVEE	30	20	242	48	237	44
5/24/01	EW	TRAKER	5	10	30	15	40	14
5/24/01	EW	TRAKER	10	10	56	12	82	24
5/24/01	EW	TRAKER	15	10	134	51	109	30
5/24/01	EW	TRAKER	20	10	45	15	186	110

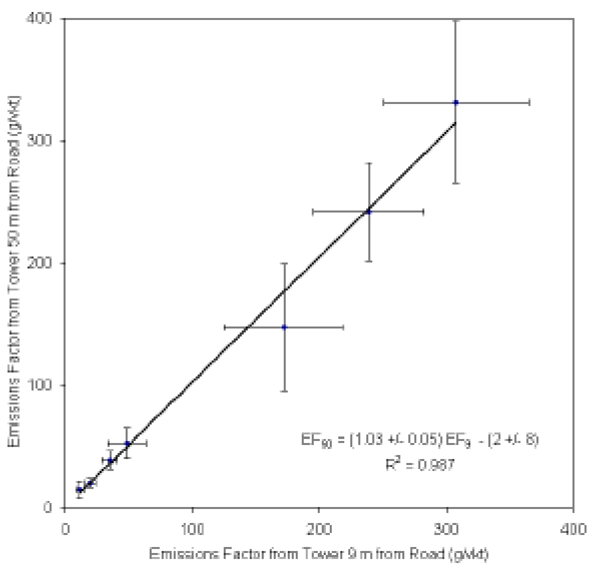


Figure 3-19. Comparison of emissions factors measured on towers 9 m and 50 m downwind of an unpaved road. Error bars on the figure represent the standard error of the flux measurements.

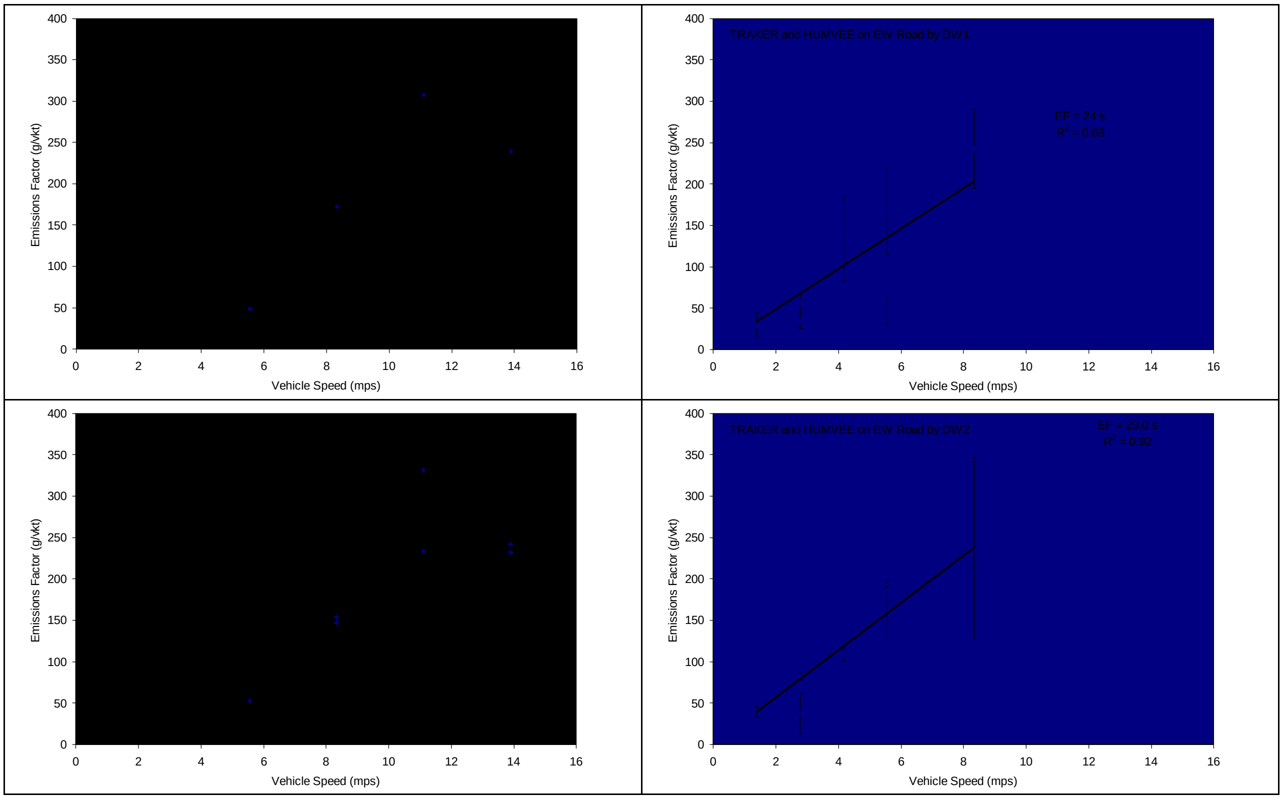


Figure 3-20. Unpaved road dust emissions factors versus vehicle speed for two weight classes of vehicles. The Ford Ranger weighs ~1.5 Mg while the TRAKER and HUMVEE weigh ~3.5 to 4 Mg.

The reasonable curve fits shown in Figure 3-20 indicate that the relationship between emissions factor and vehicle speed is approximately linear. This is consistent with the equation (See Eq 2-1) used to model unpaved road dust emissions in the U.S. E.P.A.'s AP-42 documentation (USEPA, 1995).

3.5 Comparison of TRAKER Measurements with Flux

By comparing the TRAKER signal (Eq. 1) with the emissions factors measured on the down wind towers, a calibration for the TRAKER vehicle has been developed. This calibration permits the inference of road dust emissions factors from valid TRAKER measurements.

Table 3-4 shows the average TRAKER signal measurements from the unpaved road tests. The signal was calculated independently for both the right and left inlets. With the exception of the 1.4 m/s pass on the East-West test section, signals from the left and right inlets agree with each other within the limits of the measurement uncertainty. The TRAKER signal on the East-West test section was typically more than one order of magnitude higher than on the more heavily traveled North-South test section.

In section 3.3.4, tests on paved roads in two separate locations indicated that the TRAKER signal increases approximately with the cube of the vehicle speed. In section 3.4, both our measurements and those used to develop the AP-42 emissions factors indicated that unpaved road emissions factors increase linearly with speed. Based on these two relationships, the emissions factor should be approximately proportional to the TRAKER signal raised to the 1/3 power. That is:

$$T \; ? \; T^{*}s^{3} \qquad (4)$$

$$EF \; ? \; bs \qquad (5)$$

$$? \quad EF \; ? \; kT^{1/3} \qquad (6)$$

where T is the TRAKER signal, EF is the emissions factor, s is the vehicle speed, and T^*, b, and k are all constants.

Table 3-4. Average TRAKER signals measured on unpaved road test sections at Ft. Bliss. Uncertainties are the standard errors of the means of multiple passes.

Date	Road Section	Speed (m/s)	Number of passes	TRAKER Signal Left (mg/m^3)	TRAKER Signal Right (mg/m^3)	Average TRAKER Signal (mg/m^3)
5/18/01	NS	1.4	10	5 +/- 2	9 +/- 5	7 +/- 4
5/18/01	NS	1.9	15	21 +/- 5	19 +/- 3	20 +/- 4
5/18/01	NS	2.8	18	29 +/- 29	68 +/- 33	48 +/- 31
5/18/01	NS	4.2	3	104 +/- 38	77 +/- 5	90 +/- 27
5/24/01	EW	1.4	10	173 +/- 39	388 +/- 126	280 +/- 93
5/24/01	EW	2.8	10	1005 +/- 223	1298 +/- 149	1151 +/- 190
5/24/01	EW	4.2	10	3079 +/- 776	2619 +/- 271	2849 +/- 582
5/24/01	EW	5.6	10	1735 +/- 317	2025 +/- 146	1880 +/- 247

This mathematical relationship is tested using a power law regression between the average of the left and right PM_{10} TRAKER signal as measured by the DustTraks (Table 3-4) and the emissions factors measured using the averages of the fluxes at the DW1 and DW2 towers (Table 3-3). The TRAKER signal is plotted against corresponding PM_{10} emissions factors in Figure 3-21. The resulting calibration linking the PM_{10} TRAKER signal to the emissions factors is shown in the figure. The exponent of the TRAKER signal (0.33? 0.06) is consistent with Eq (6). The coefficient of the TRAKER term has a geometric standard error ($?_g$) of 1.5. Note that all points in the figure lie within 2 sigma of the regression line.

The relationship shown in Figure 3-21 is used later in the report to estimate emissions factors from paved road and unpaved roads in Ada and Canyon Counties. It should be noted that the range of emissions factors used for the calibration (i.e. 10 to 150 g/vkt) is generally one or two orders of magnitude higher than the typical emissions factors for paved roads. As a result, emissions factors for the Treasure Valley are calculated by extrapolating the calibration shown in Figure 3-21 to lower values. Furthermore, emissions factors calculated using this relationship apply to vehicles in the same weight class as the TRAKER. We note that the TRAKER weighs ~3.5 Mg which is approximately equal to the fleet average vehicle weight for most areas (3.0–3.5 Mg)

The DustTrak instrumentation onboard the TRAKER vehicle has a precision of 1? g/m^3. Thus, the smallest measurable difference in concentration between the tire and the background monitors is 1 ? g/m^3. This corresponds approximately to a single-point minimum detection limit equivalent to an emissions factor of 0.9 g/VKT, meaning that any 1-second measurement can only be resolved to within this value. Note that substantially smaller emissions factors can be measured with the TRAKER if multiple points are used to calculate an average. At the other end of the measurement range, DustTrak readings above 150 mg/m^3 are not reliable. This corresponds to an emissions factor for PM_{10} of approximately 50 g/VKT. Note that the upper end of the range can be stretched to 110 g/VKT if the optional dilution system is in use. This ceiling can be further stretched to 160 g/VKT if the correlation between the $PM_{2.5}$ and the PM_{10} DustTrak measurements is utilized (see section 3.3.1.1).

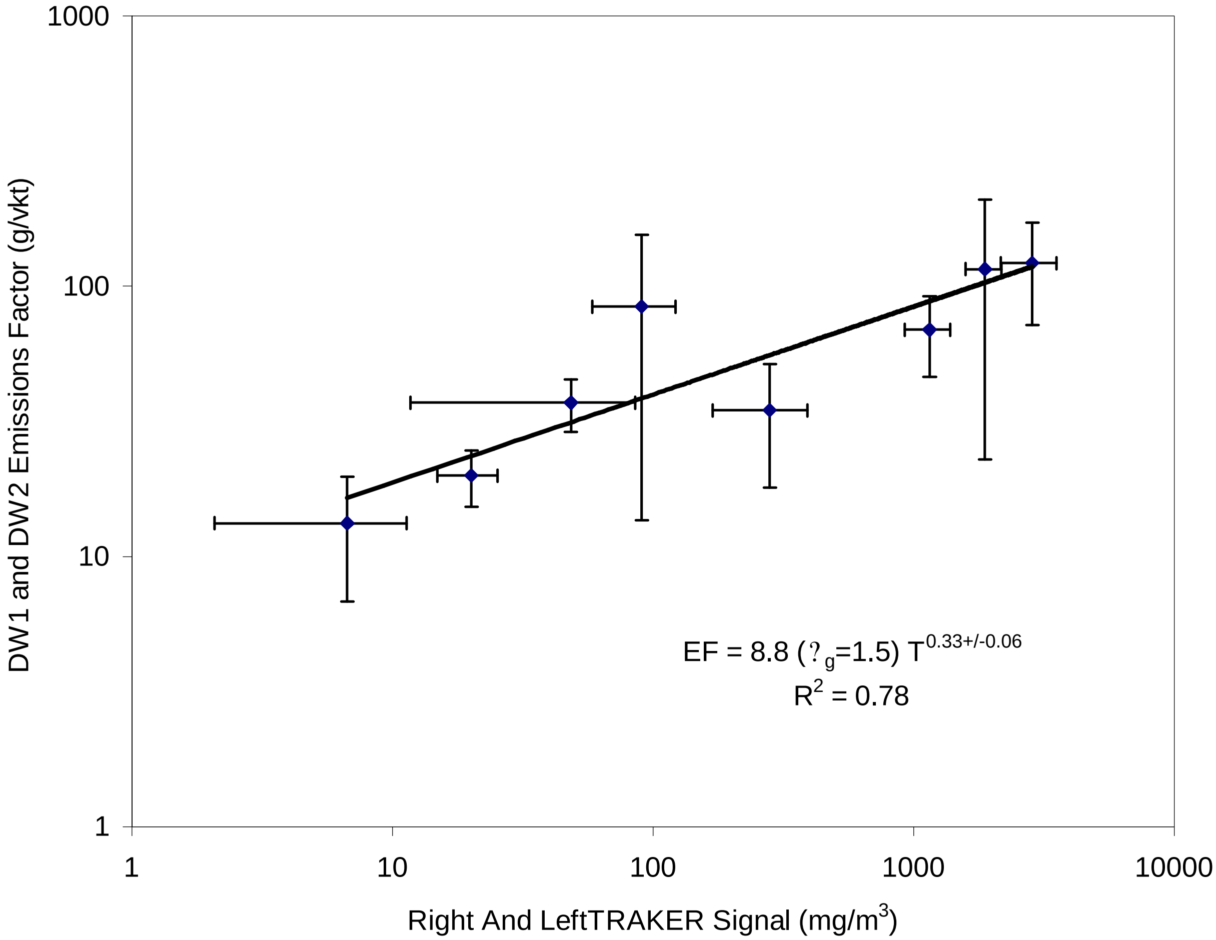


Figure 3-21. Relationship between unpaved road dust PM_{10} emissions factors and the TRAKER signal from Ft. Bliss. The error bars on the figure are the standard errors of the mean of each measurement.

3.5.1 Comparison with silt

Figure 3-22 illustrates how TRAKER results relate to manual silt loadings in the Treasure Valley. Silt loadings are determined by sweeping or vacuuming loose particles from several specified areas on a stretch of road. The same samples are sieved to determine the silt fraction and the quantity of larger particle sizes. A comprehensive discussion of the silt loading methods used in the Treasure Valley is given in Chapter 2. For the data plotted in Figure 3-22, the TRAKER measurement was conducted on the same stretch of road as the silt loadings prior to the beginning of road-vacuuming. Thus, the two measurements are effectively collocated.

The TRAKER measurement and manual silt loadings for the Treasure Valley are slightly correlated. If a linear relationship is assumed, the R^2 value for the regression is 0.11. If, on the other hand, a power-law relationship is assumed, the R^2 value increases to 0.29, still not high enough to indicate a strong relationship between the two parameters. It is interesting that the correlation between the TRAKER and silt loadings was substantially higher during an earlier study in Las Vegas (Kuhns et al., 2001). Figure 3-23 shows the relationship between TRAKER measurements (T^*) and manually determined silt loadings (sL) in Las Vegas. Note that the power-law relationship between sL and T^* is the same for both Las Vegas and the Treasure Valley, namely that sL is equal to T^* raised to the 0.47 power. However, the relationship is stronger in the Las Vegas data (R^2=0.47) than in the Treasure Valley data (R^2=0.29). There are two possible explanations for the difference between the Las Vegas and the Treasure Valley data. First, it is possible that the road dirt in Las Vegas is more uniform in size distribution across the valley. That is, the relationship between 75?m dust particles (this is the nominal upper limit of the dust particles that are measured using the silt technique) and 10?m particles (this is the upper limit of dust particles measured by the TRAKER) is more consistent in Las Vegas than in the Treasure Valley. Second, the Las Vegas data span a higher range of numbers (approximately 2.8 orders of magnitude) than the Treasure Valley data (approximately 1.6 orders of magnitude). Perhaps the higher range of numbers in the Las Vegas study serves to smooth out the noise in the relationship between TRAKER signal and silt loading, resulting in a better correlation between the two.

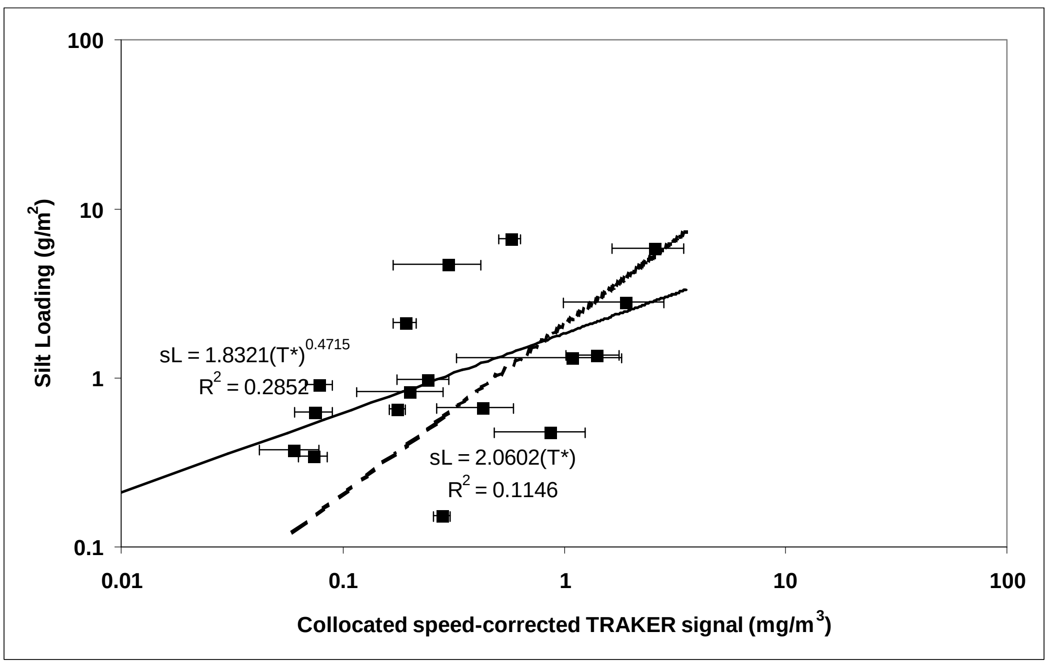


Figure 3-22. Relationship between manually collected silt loadings and the speed-corrected TRAKER signal in the Treasure Valley Idaho. TRAKER measurements were conducted over the same stretch of road where dirt was subsequently removed by vacuuming for silt analysis. The solid line represents a power law regression of the data while the dashed line is the linear regression. The low R^2 values for either regression indicate that the TRAKER signal and silt loadings are only weakly correlated. Silt loadings shown in the Figure represent samples obtained in both summer and winter 2001. The summer 6^{th} st. sample has been omitted.

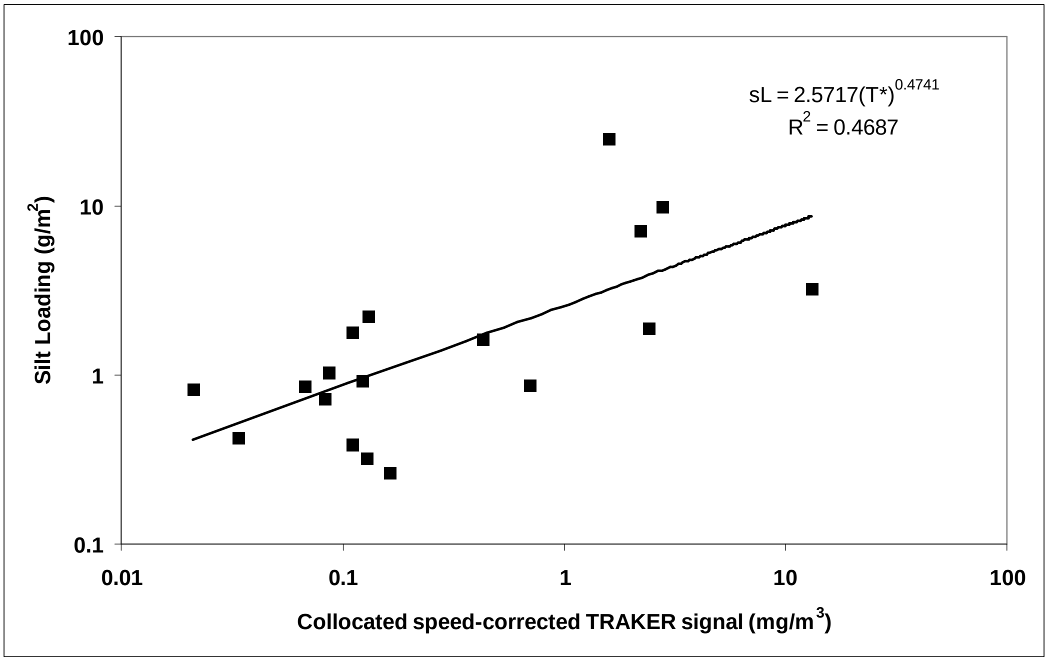


Figure 3-23. Silt Loading vs. Speed Corrected TRAKER signal for 18 silt-loading sites in the Las Vegas Valley. A power law regression (R^2 = 0.47) shows that silt loading is proportional to the speed-corrected TRAKER signal raised to the 0.47 power.

4. RESULTS OF TRAKER MEASUREMENTS IN THE TREASURE VALLEY

The TRAKER measurements conducted as part of the Treasure Valley Road Dust Study fall into three categories: Street surveys, multiple measurements on a closed loop of roads, and special experiments. Al measurements were performed either during the summer or winter 2001 field campaigns.

The TRAKER was used to survey several hundreds of miles of streets in Ada and Canyon Counties to assess the spatial distributions of road dust emissions and gather information on parameters that affect a particular roadway's potential for emissions. These data are used to express emissions factors in terms of measured or modeled parameters such as roadway VMT, speed, and setting. The results from this portion of the study are used in assembling the emissions inventories discussed in Section 5.

A set of roads was traversed with the TRAKER on multiple occasions during both winter and Summer 2001. The roads constituted a closed loop and were chosen to represent a variety of conditions and road classes. The data from the loop are used to assess temporal fluctuations in road dust emissions. These include seasonal differences (summer vs. winter) as well as day-to-day and week-to-week differences. The loop data are also used to assess the effect of precipitation on unpaved road emissions.

Two special studies experiments were also performed during the TVRDS. In the winter, an experiment was coordinated with the Ada County Highway District (ACHD) to assess the short-term effects of road sanding on dust emissions. During the summer, a similar experiment tested the short-term benefits of street sweeping.

4.1 TRAKER Data Processing

Processing of data involved a series of steps. First, each TRAKER data point was assessed for validity; the criteria for the validity of an individual data point were discussed in Section 3. Note that the right inlet on the TRAKER was not active for a portion of the winter 2001 season. Therefore, for consistency, all data presented in this section are based on the TRAKER signal from the left inlet only. Second, each valid measurement was cast in terms of an emissions potential. The emissions potential is a characteristic of the road and can be thought of as a measure of the road "dirtiness". Third, because each TRAKER data point corresponds to a point in space on the Treasure Valley roadway network, Geographic Information System (GIS) coverages were used to assign characteristics to the TRAKER measurement. Thus, each data point was associated with a particular segment of road (link) that has its own set of attributes such as number of lanes, travel speed, and setting. Fourth, street survey measurements that associated with a particular road segment were averaged by season (either winter or summer) and used to infer trends in road dust emissions with respect to the attributes of that road segment. TRAKER loop measurements were averaged by road segment and sample date.

The TRAKER was used in the TVRDS primarily to estimate PM_{10} emissions. However, consideration of the distribution of road dust particle sizes allows for the calculation of $PM_{2.5}$ emissions as well. Details of this procedure are provided in section 4.1.3.

4.1.1 Converting TRAKER Data Into Emissions Potentials

All invalid TRAKER data points (according to the criteria outlined in Section 3) were removed from the dataset. The parameter used in considering valid TRAKER data is the emissions potential of the road. Recall from Section 3 that:

$$T = T_T - T_B \quad (4\text{-}1)$$

$$T = T^* s^3 \quad (4\text{-}2)$$

$$EF = bs \quad (4\text{-}3)$$

$$EF = kT^{1/3} \quad (4\text{-}4)$$

where T_T is the PM_{10} concentration at the vehicle tire, T_B is the background aerosol concentration measured at the front bumper, T is the differential TRAKER signal, EF is the emissions factor, s is the vehicle speed, and T^*, b, and k are all constants for a given road segment. It follows that

$$EF = \left[(k \cdot T^{1/3} / s) \cdot s\right] \quad (4\text{-}5)$$

$$b = (k \cdot T^{1/3} / s) \quad (4\text{-}6)$$

where the constant, b, is the road dust emissions potential and is related only to the "dirtiness" of the road. That is, for a given road, b is constant regardless of the speed that the TRAKER traverses the road and has units of [g/vkt/mps] where vkt is the vehicle kilometers traveled and mps is the speed of travel in meters per second. Actual emissions factors for the road (units of g/vkt) are obtained by multiplying b by the speed of the vehicle that is traversing the road.

The emissions potential was calculated for each valid TRAKER data point. Note that in some cases, the differential signal T can be negative. This occurs if the background PM concentration measured on the bumper of the vehicle is higher than the influence concentration behind the tire due to instrument noise or a time delay between when a "dirty" air pocket passes by the bumper and then the tires. It is important to retain these negative values in the database so as not to introduce a bias when calculating averages.

4.1.2 Associating TRAKER Data With Roads and Settings

All data were imported into a GIS-format database. Using the GIS coverages shown in Table 4-1 and a software utility for joining spatial data, each TRAKER measurement was associated with a road segment or type, county, and setting (urban/rural). For non-residential roads, the TRAKER measurement was associated with a link in the Traffic Demand Model (TDM) that was provided by COMPASS. Each link in the TDM is attributed with a road class (e.g. principal arterial, collector, etc). Residential roads are not reflected in the TDM as physical entities; instead, they are grouped and represented as "Centroid Connectors". For residential roads, the TRAKER measurement was flagged as "residential" based on spatial joins with separate Ada County and Canyon County street coverages, shown in Table 4-1 as "adastr" and "canstr", respectively.

When attributing a road dust emissions potential to an individual road segment, 1-second TRAKER data for that road segment (link) were averaged. If there were fewer than 10 valid data points for that road segment, then the road segment was not considered to have a valid measurement.

Table 4-1. GIS coverages used in TRAKER data analysis

Coverage/Fields used	**Coverage/Field Description**
Coverage: TRAKER Measurements **Filename:** ALL_BRD_TRAKER_02.mdb **Source:** DRI	**Coverage Description:** Point coverages of all measurements conducted with TRAKER. This coverage is used to assign attributes to all TRAKER measurements. Attributes include, which road segment the measurement was conducted on, which County, whether or not the TRAKER measurement corresponds to an urban or a rural area. 
Data Fields Used	*Field Description*
Datetime	The date and time of each measurement in MM/DD/YY HH:MM:SS format. The dates are important for resolving temporal trends in road dust emissions and are also used as a key between all measurements (GPS, DustTraks, PSAs, Database)
Lat, Lon, Elev	The latitude, longitude and elevation of each measurement as calculated from differentially-corrected GPS signals.

Table 4-1. (cont) GIS coverages used in TRAKER data analysis

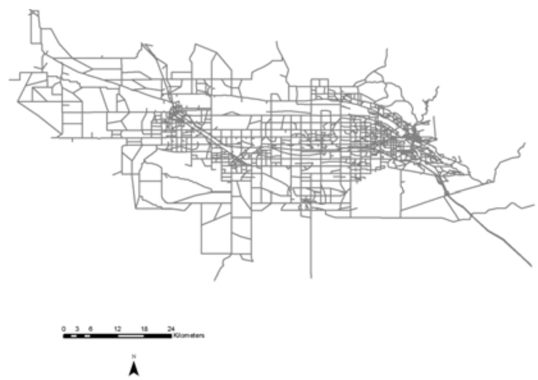
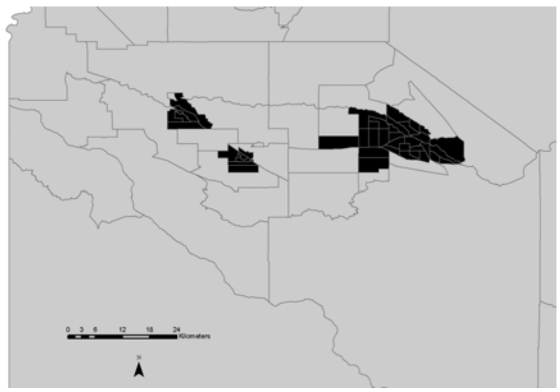
Coverage/Fields used	**Coverage/Field Description**
Coverage: 2000 TDM **Filename:** 2000.shp **Source:** COMPASS	**Coverage Description:** Year 2000 Traffic Demand Model analysis results. The TDM uses optimization algorithms to determine how traffic flows between Traffic Analysis Zones (TAZ). Major roadways are included as individual links in the TDM coverage. Residential areas are represented by a single TAZ, with one or more links that access the larger network. i.e individual residential streets are not represented. This coverage is used to associate TRAKER data to the major streets in the traffic demand network. 
Data Fields Used	*Field Description*
A, B	The A and B fields correspond to node ID numbers within the network. Specifying A and B uniquely specifies a link in the TDM. Note that individual links only support traffic flow in one direction. Thus, it is possible to have two links between any two nodes, one per direction of travel.
Speed (mph)	Specifies the vehicle speed in miles per hour on a particular link.
FTYPE	A number between 1 and 20 that assigns a roadway type to the link: 1-2 ? Interstate; 3-6 ? Principal Arterial; 7-10 ? Minor Arterial; 11-14 ? Collector; 15-18 ? Local; 19 ? Interstate Ramp; 20 ? Centroid Connector. A centroid connector does not necessarily correspond to an actual road, but rather is used as a surrogate for all traffic flow coming out of a TAZ.
THRULANE	The number of travel lanes on the link.
COUNTY	Specifies the County that the link is located in : 1 for Ada, 2 for Canyon.
ADJCNT	Adjusted Traffic Volume on a vehicles per average weekday basis. This field is only active if actual traffic counts have been obtained for the link. Note that the total number of vehicles traversing a link is reported. Thus, to obtain the traffic volume on a per lane basis, you must divide ADJCNT by the THRULANE field.
V1_1	Traffic Volume in average vehicles per weekday obtained from TDM analysis results. The total number of vehicles traversing a link is reported. Thus, to obtain the traffic volume per lane, you must divide V1_1 by the THRULANE field.
Coverage: 2010 TDM **Filename:** 2010.shp **Source:** COMPASS	**Coverage Description:** Year 2010 Traffic Demand Model projected analysis results. The format for this data file is the same as for the 2000 TDM coverage except that the ADJCNT field is not used.

Table 4-1. (cont) GIS coverages used in TRAKER data analysis

Coverage/Fields used	**Coverage/Field Description**
Coverage: 2015 TDM **Filename:** 2015.shp **Source:** COMPASS	**Coverage Description:** Year 2015 Traffic Demand Model projected analysis results. The format for this data file is the same as for the 2000 TDM coverage except that the ADJCNT field is not used.
Coverage: 2020 TDM **Filename:** 2020.shp **Source:** COMPASS	**Coverage Description:** Year 2020 Traffic Demand Model projected analysis results. The format for this data file is the same as for the 2000 TDM coverage except that the ADJCNT field is not used.
Coverage: Ada streets **Filename:** adastr.shp **Source:** COMPASS	**Coverage Description:** Coverage of Ada County streets. Associated data tables include information on whether or not a particular road segment is a residential street. 
Data Fields Used	*Field Description*
STR_CLA	Street Class. This field identifies residential road segments and is used to tie TRAKER data with residential roads that are not covered by the TDM 2000 coverage.
Coverage: Canyon streets **Filename:** canstr.shp **Source:** ESRI	**Coverage Description:** Coverage of Canyon County streets. This coverage was used to identify residential Canyon County streets. TRAKER data associated with these streets were tagged manually and this coverage was used for visual verification only.

Table 4-1. (cont) GIS coverages used in TRAKER data analysis

Coverage/Fields used	Coverage/Field Description
Coverage: Census Tracts **Filename:** idtrct.shp **Source:** ESRI	**Coverage Description:** Area coverage of the state of Idaho of the year 2000 Census Data by tract. This coverage was used to assess whether a given TRAKER measurement was performed in a rural or an urban area: Rural? population/sq. mile <1000, Urban ? population/sq. mile >1000. 
Data Fields Used	*Field Description*
Area	The spatial area in square miles of the census tract.
POP1997	1997 Population in the census tract. This number is used as an estimate of the year 2000 population.
COUNTY_FIPS	ID number that identifies the county that the census tract is located in: 001 for Ada, 027 for Canyon

4.1.3 Size Distributions of Road Dust Emissions: The relationship between $PM_{2.5}$ and PM_{10} emissions

The size distributions of paved and unpaved road dust emissions are shown in Table 4-2. For paved road dust, the size distribution was derived from all valid TRAKER data points obtained with the PSA during measurements conducted in the winter and summer of 2001 in the Treasure Valley. The PSA counts particles in each of 15 size bins. Because the instrument uses light scattering to make size measurements, the particle size reported by the PSA is an "optical" particle size. An equivalent aerodynamic particle size can be derived if the density of the particles is known. For the present analysis, the density of silica (2.6 g/cm^3) was used to infer aerodynamic particle sizes from optical particle sizes. The $PM_{2.5}$ fraction was calculated by summing the mass of all particles in bins 1 through 6 corresponding to aerodynamic diameters of 0.48 to 2.58 microns. PM_{10} was calculated by summing the mass of all particles in bins 1 through 10 and half the mass of particles in bin 11. This corresponds approximately to the aerodynamic particle size range of 0.48 to 9.87 microns.

Size distributions for unpaved road dust emissions were also measured using the PSA particle size analyzer. However, in the case of unpaved roads, the PSA data were obtained from instruments that were mounted on two towers downwind of an unpaved road in Ft. Bliss, TX (see Section 3 for a description of those experiments).

Table 4-2 shows that there are no statistically significant differences between the paved and unpaved road dust size distributions except for bin 1, corresponding to a size range that contains less than 1 percent of the total PM_{10} mass. Since the data for paved roads is based on a much more extensive database, the size distributions for unpaved roads and paved roads are assumed to be identical within the measurement errors and appear in the far right column in the table. According to the data, $PM_{2.5}$ emissions only constitute 5.7% of the PM_{10} emissions.

Table 4-2. Size distributions of paved and unpaved road dust emissions

Bin	Optical Diameter Range (? m)	Aerodynamic Diameter Range (? m)[a]	Log mean diameter (? m)	Percent of PM_{10} based on paved road emissions [b]	Percent of PM_{10} based on Unpaved Road emissions [c]	Difference between paved and unpaved statistically significant?	Value Used
1	0.3 - 0.4	0.48 - 0.64	0.56	0.24%	0.08%	Yes	0.24%
2	0.4 - 0.5	0.64 - 0.81	0.72	0.17%	0.11%	No	0.17%
3	0.5 - 0.65	0.81 - 1.05	0.92	0.43%	0.32%	No	0.43%
4	0.65 - 0.8	1.05 - 1.29	1.16	0.50%	0.48%	No	0.50%
5	0.8 - 1.	1.29 - 1.61	1.44	1.19%	1.13%	No	1.19%
6	1. - 1.6	1.61 - 2.58	2.04	3.16%	2.47%	No	3.16%
7	1.6 - 2.	2.58 - 3.22	2.88	12.22%	9.54%	No	12.22%
8	2. - 3.	3.22 - 4.84	3.95	19.95%	22.02%	No	19.95%
9	3. - 4.	4.84 - 6.45	5.59	12.67%	15.62%	No	12.67%
10	4. - 5.	6.45 - 8.06	7.21	21.78%	20.36%	No	21.78%
11	5. - 7.5	8.06 - 12.09	9.87	27.69%	27.86%	No	27.69%
$PM_{2.5}$ (0.48 - 2.58)	0.3 - 1.6	0.48 - 2.58		5.70%	4.59%	No	5.70%
PM_{10} (0.48 - 9.87)	0.3 - 6.12	0.48 - 9.87		100.00%	100.00%	N/A	100.00%

[a] Aerodynamic diameter based on an assumed particle density of 2.6 g/cm^3

[b] Size distributions of paved road emissions were calculated based on GRIMM particle size analyzers deployed in the sampling manifold of the TRAKER during winter and summer portions of the TVRDS.

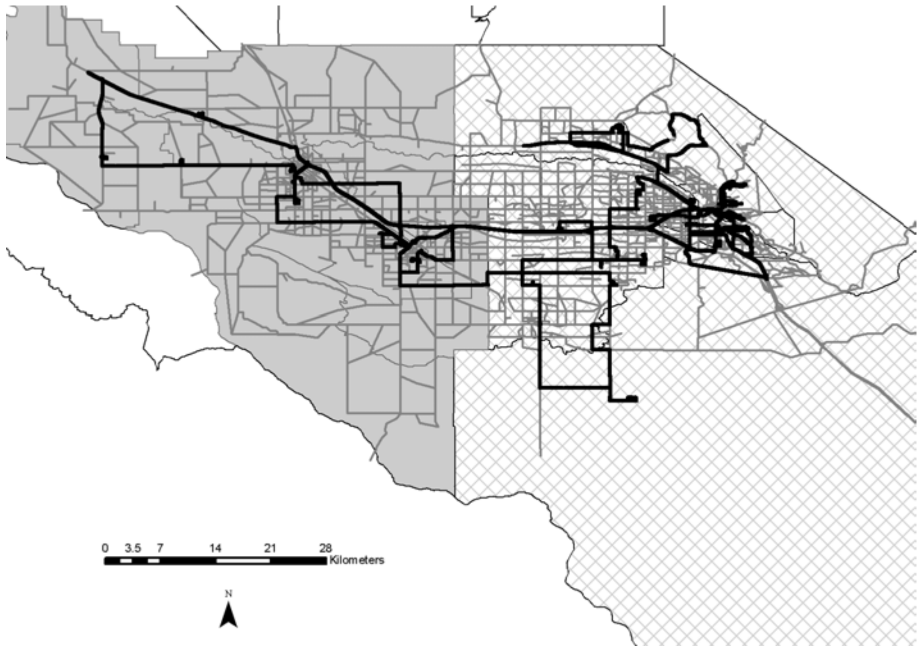
[c] Size distributions for unpaved roads were calculated from GRIMM particle sizers deployed on two towers downwind of an unpaved orad at Ft. Bliss, TX.

4.2 TRAKER Street Surveys

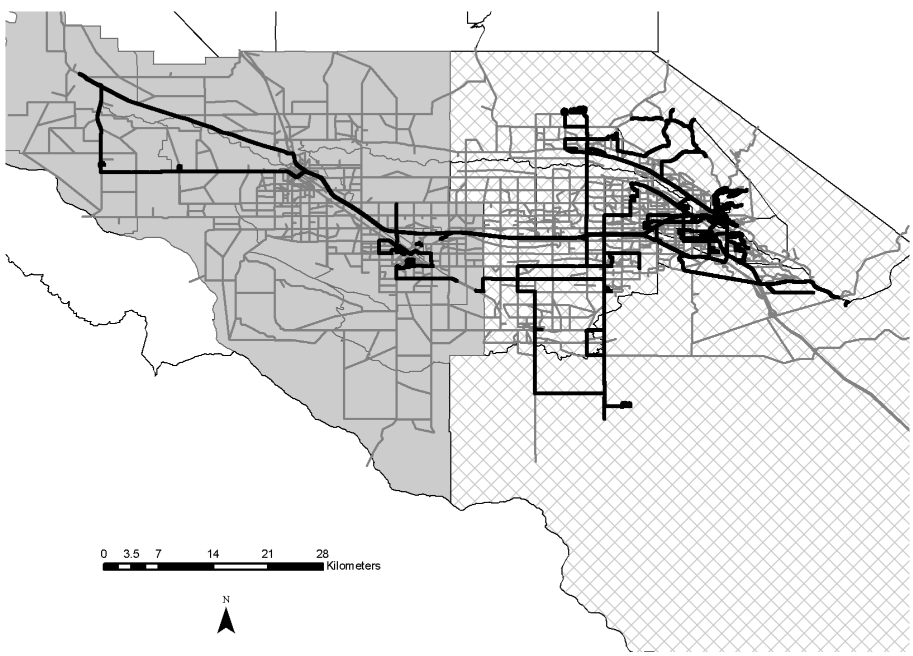
Figure 4-1 shows the street surveys conducted by TRAKER. The winter and summer field campaigns, each surveying a total distance in excess of 400 km (250 miles), essentially cover the same streets. Table 4-3 shows the number of kilometers of valid TRAKER data categorized by season, county, and road class.

4.2.1 Paved Roads

Historically, analysis of dust emissions from paved roads has considered the road class as a parameter in deciding the appropriate emissions factors (e.g. USEPA, 1995). However, it is important to note that the road classification is just a functional classification based on the implications that the road has for transportation. That is, the road class is based on parameters such as the speed of traffic on the road, the number of lanes, and the origin and destination of the road segment. From a road dust emissions perspective, the “classification” of the road in terms of its functionality in transportation networks is not, strictly speaking, relevant. The relevant parameters are the time of the year, the setting of the road, the speed that vehicles traverse the road, and the number of vehicles that traverse the road per lane of traffic. The use of road class in prior work is due primarily to an absence of a dataset that is large enough to assess these factors independently. Thus, in the analysis of TRAKER data, the road class is not considered as an independent predictive parameter. Instead, TRAKER data analysis directly considers the road speed, number of vehicles, and location as independent parameters.



a.



b.

Figure 4-1. Map of TRAKER Street Survey Route. a. Winter field study, b. summer field study. The black lines are streets that were traversed with the TRAKER. The gray area on the left is Canyon County and the thatched area on the right is Ada County.

Table 4-3. TRAKER street survey coverages by season, county, and road class.

Winter			Summer		
County	**Road Class**	**kilometers covered with TRAKER**	**County**	**Road Class**	**kilometers covered with TRAKER**
Ada	Collector	62.0	Ada	Collector	65.8
Ada	Interstate	41.1	Ada	Interstate	47.8
Ada	Local/Residential	44.6	Ada	Local/Residential	46.3
Ada	Minor Arterial	60.9	Ada	Minor Arterial	75.7
Ada	Principal Arterial	51.9	Ada	Principal Arterial	60.1
Ada	Unpaved	14.9	Ada	Unpaved	18.4
Ada	**All roads**	**275.4**	**Ada**	**All roads**	**314.0**
Canyon	Collector	9.5	Canyon	Collector	8.5
Canyon	Interstate	30.3	Canyon	Interstate	33.4
Canyon	Local/Residential	15.3	Canyon	Local/Residential	11.3
Canyon	Minor Arterial	56.4	Canyon	Minor Arterial	43.0
Canyon	Principal Arterial	39.9	Canyon	Principal Arterial	23.8
Canyon	Unpaved	0.0	Canyon	Unpaved	0.0
Canyon	**All roads**	**151.5**	**Canyon**	**All roads**	**120.1**
Ada & Canyon	**All roads**	**426.9**	**Ada & Canyon**	**All roads**	**434.1**

4.2.1.1 Effect of Speed and VMT

The effect of vehicle speed and the volume of traffic per lane on road dust emissions potentials were assessed for all non-residential roads. Residential roads were not included because they are not physically represented in the Traffic Demand Model. Therefore, the associated speeds and traffic volumes were also not available for residentials. It is important to note that "speed" here refers to the speed attributed to the road in the Traffic Demand Model and not the speed of the TRAKER vehicle itself. The dependence of the emissions potential on speed and traffic volume was assumed to have the following form:

$$b = C_{C,S,T} \cdot s^{-x} \cdot v^{-y} \tag{4-7}$$

or equivalently,

$$\log(b) = lC_{C,S,T} - x \cdot \log(s) - y \cdot \log(v) \tag{4-8}$$

where b is the emissions potential in units of [g/vkt/mps], $C_{C,S,T}$ is a constant that is specific to the county (Ada or Canyon), setting (urban or rural), and time of year (winter or summer), $lC_{C,S,T}$ is the base 10 logarithm of $C_{C,S,T}$, s is the road speed, v is the number of vehicles per lane per day, and x and y are positive empirical constants. The form of Eq (4-7) is appealing because as speed and traffic volume increase, the road dust emissions potential decreases, a result that is consistent with physical expectation.

The results of regressions of log(b) vs. log(s) and log(v) are shown in Table 4-4. Three sets of linear regression results are shown in the Table: Log (b) vs. Log(s) and Log(v) shown as option 1 in the table, Log(b) vs. Log(s) only shown as option 2 in the table (assumes emissions potential independent of per lane traffic volume), and Log(b) vs. Log(v) only shown as option 3 in the table (assumes emissions potential independent of road speed). For each of the three regressions, R^2 and P-values are also reported. R^2 can be thought of as the fraction of the variance in Log(b) that is explained by the regression. The P-value for a parameter is an indicator of the probability that the fit for that parameter is not different from zero. In general, a low P-value suggests that a discernible relationship exists between the dependent (Log(b)) variable and the independent (Log(s), Log(v), or both) variable(s). Option 1 resulted in very good curve fits with R^2 ranging from 0.83 (Winter-Canyon-Rural) to 0.99 (Summer-Ada-Rural). When Log(s) was the only independent variable (option 2) R^2 ranged from 0.77 (Winter-Canyon-Rural) to 0.98 (Summer-Ada-Rural). Option 3 resulted in R^2 ranging from 0.47 (Summer-Canyon-Urban) to 0.95 (Summer-Ada-Urban). Option 2 was chosen as the best option for use in the Treasure Valley Road Dust Study for three reasons. First, though option 1 resulted in better curve fits, the relationship between the variables was not consistent. The exponent, y, for per lane volume was negative for Summer-Canyon-Urban and Winter Canyon-Rural, suggesting an increase in emissions potential, b with increasing volume. However, y was positive for all other cases, suggesting a decrease in b with increasing volume. These results are not physically consistent. Second, road speed and per lane traffic volume are positively correlated (see Figure 4-2). Thus, they are not independent variables. Third, road speed is a known quantity while volume is obtained from TDM model results. This adds uncertainty to the variable v.

Table 4-4. Results of regression of log(emissions factor, b) vs. log (speed, s) and log (volume per lane, v).

Time and Location			Option 1 Regressions of Log(b) vs. Log(s) and Log(v)					Option 2 Log(b) vs. Log(s) only; y=0			Option 3 Log(b) vs. Log(v) only; x=0		
Season	County	Setting	R^2	x	P_x	y	P_y	R^2	x	P_x	R^2	y	P_y
S	Ada	Rural	0.99	1.07	0.0002	0.12	0.0175	0.98	1.47	0.0000	0.90	0.37	0.0001
S	Ada	Urban	0.95	0.20	0.6300	0.48	0.0199	0.88	1.39	0.0002	0.95	0.56	0.0000
S	Canyon	Rural	0.93	1.18	0.1720	0.22	0.2289	0.88	2.05	0.0055	0.86	0.45	0.0076
S	Canyon	Urban	0.89	4.01	0.1041	-0.42	0.2671	0.77	2.03	0.0496	0.47	0.31	0.2035
W	Ada	Rural	0.97	0.13	0.7292	0.34	0.0217	0.88	1.32	0.0017	0.97	0.38	0.0000
W	Ada	Urban	0.91	0.59	0.2447	0.33	0.1083	0.85	1.38	0.0004	0.88	0.53	0.0002
W	Canyon	Rural	0.83	1.79	0.0341	-0.17	0.2597	0.77	1.05	0.0039	0.54	0.19	0.0366
W	Canyon	Urban	0.94	1.36	0.1224	0.27	0.3249	0.89	1.86	0.0165	0.73	0.67	0.0637

Considering speed, setting, and time of year as the only parameters that determine road dust emissions potentials from paved roads, Equation (4-7) simplifies to

$$b ? C_{C,S,T} ?s^{?x} \qquad \text{Eq(4-8)}$$

The final values for $C_{C,S,T}$ and the exponent x are shown in Table 4-5. Note that the table also lists residential roads but that the x values for those roads are zero (i.e. no dependence on road speed). The curve fits corresponding to the non-residential entries in Table 4-5 are shown in Figure 4-3. In general, the regressed values for the exponent x and $C_{C,S,T}$ fit the original dataset well, within the limits of uncertainty. Table 4-6 shows a breakdown of emissions potentials and emissions factors based on the year 2000 Treasure Valley Roadway network. In obtaining the averages in Table 4-6 each link in the Traffic Demand Model was weighted equally regardless of link length or traffic volume. This averaging scheme provides an overview of the range of emissions characteristics. A discussion of road dust emissions resulting from individual activities and road types is provided in the following Chapter.

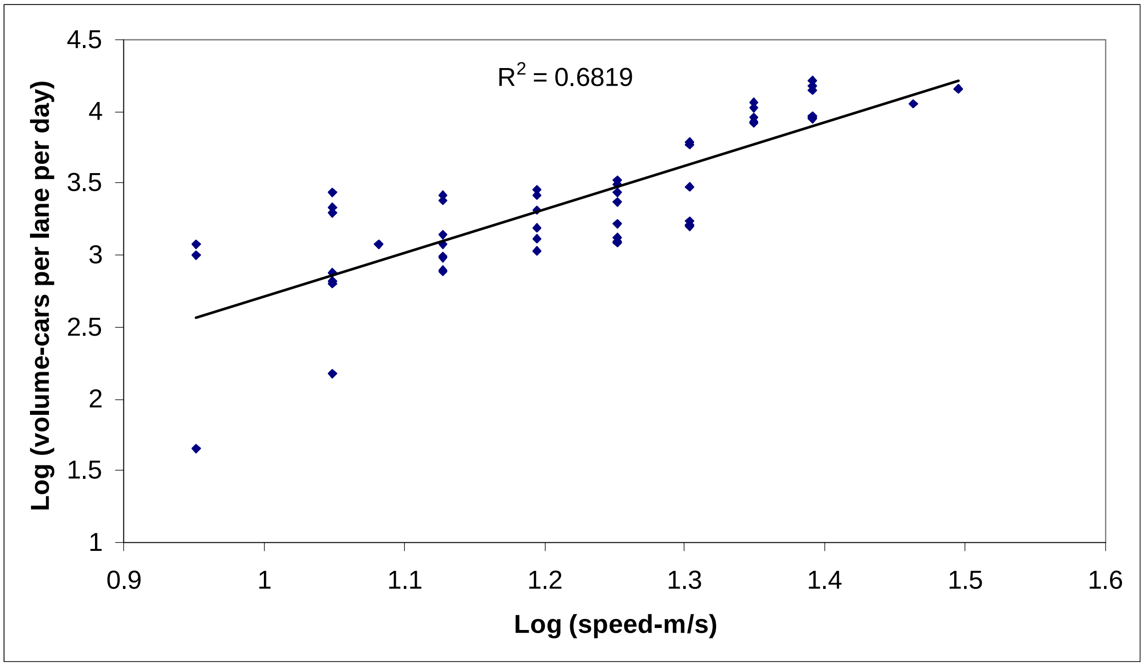


Figure 4-2. Chart showing positive correlation between road speed and per lane traffic

Table 4-5. Final regression results of emissions potential vs. season, county, setting, and road speed. Use of these parameters requires that the speed s in Eq. (4-8) have units of m/s.

Season	County	Setting	RT	$C_{C,S,T}$ [g/vkt/mps]	x (mps)
S	Ada	Rural	non-residential	14	-1.47
S	Ada	Urban	non-residential	15	-1.39
S	Canyon	Rural	non-residential	71	-2.05
S	Canyon	Urban	non-residential	90	-2.03
W	Ada	Rural	non-residential	15	-1.32
W	Ada	Urban	non-residential	24	-1.38
W	Canyon	Rural	non-residential	5	-1.05
W	Canyon	Urban	non-residential	71	-1.86
S	Ada	Rural	residential	0.67	0
S	Ada	Urban	residential	0.76	0
S	Canyon	Rural	residential	0.95	0
S	Canyon	Urban	residential	1.32	0
W	Ada	Rural	residential	0.77	0
W	Ada	Urban	residential	1.04	0
W	Canyon	Rural	residential	0.71	0
W	Canyon	Urban	residential	1.00	0

It is interesting that while emissions potentials span a range of a factor of 6.3 (min = 0.21 [g/vkt/mps]; max = 1.32 [g/vkt/mps]), actual emissions factors only span a range of a factor of 2.8 (min = 3.3 [g/vkt]; max = 9.4 [g/vkt]). This results because the emissions potential is multiplied by the speed to arrive at an emissions factor and because roads with lower emissions potentials tend to have higher speeds. In practical terms, this means that whereas high speed roads are much cleaner than low speed roads, there are only modest differences in emissions on a per vehicle kilometer traveled basis. This result has profound implications for designing effective control strategies for road dust emissions from paved roads.

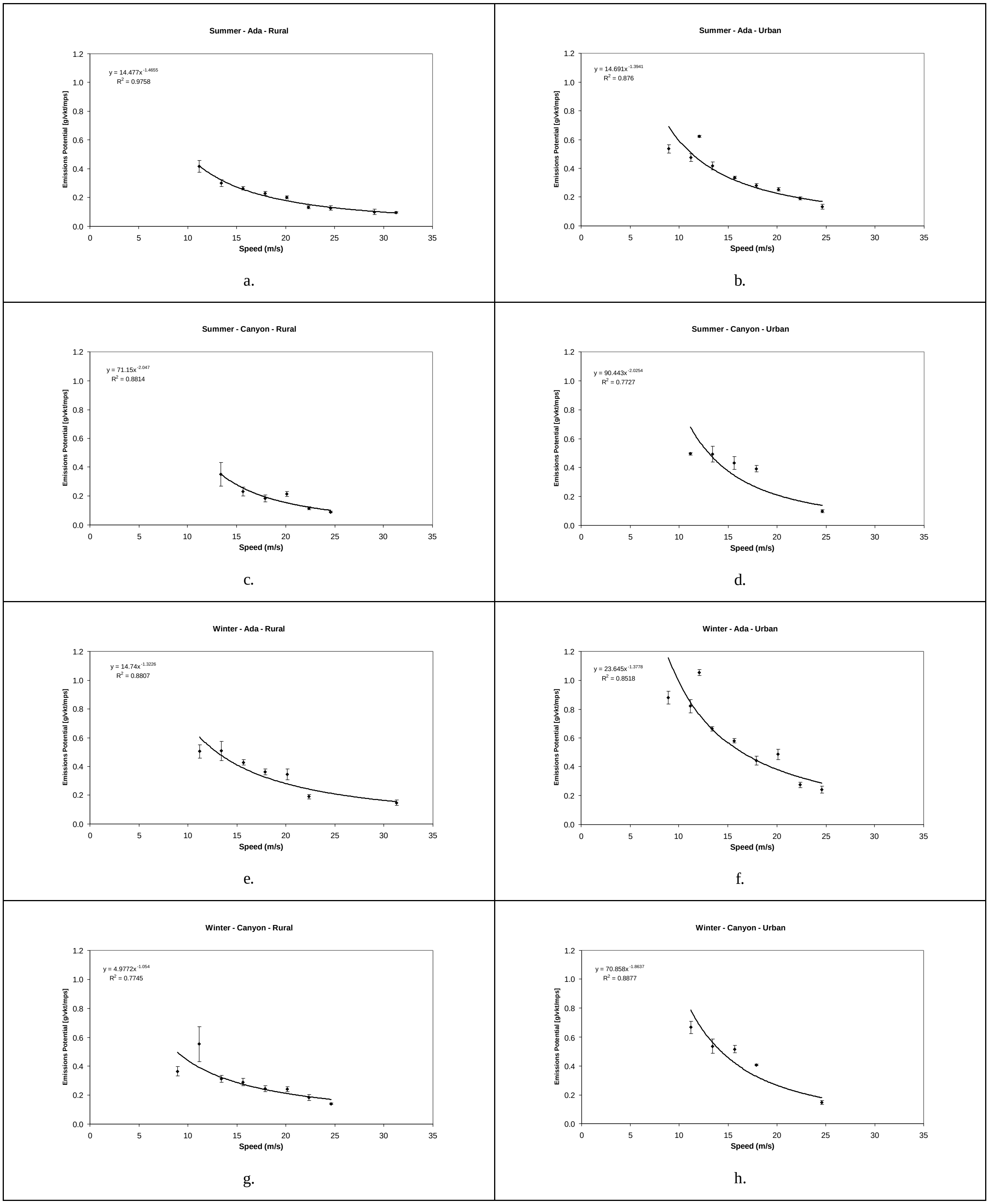


Figure 4-3. Regression results of emissions potential vs. speed. a-d: Summer and e-h: Winter; a,b,e,f: Ada; c,d,g,h: Canyon; a,c,e,g:Rural; b,d,f,h: Urban. Vertical bars indicate the standard error.

Table 4-6. Table of Emissions Potentials and Emissions Factors by Season, County, Setting, and Road Class for Year 2000.

Season	County	Setting	Road Class	Emissions Potential (g/vkt/mps)	Standard deviation of Emissions potential	Emissions Factor (g/vkt)	Standard Deviation of Emissions Factor	Average Speed (m/s)
S	Ada	Rural	Arterial	0.24	0.06	3.95	0.56	17.1
S	Ada	Rural	Collector	0.38	0.14	4.48	0.67	13.0
S	Ada	Rural	Interstate	0.21	0.13	3.61	0.72	20.7
S	Ada	Rural	Local/Residential	0.63	0.11	4.46	0.28	7.5
S	Ada	Urban	Arterial	0.35	0.09	5.11	0.68	15.0
S	Ada	Urban	Collector	0.52	0.16	5.72	1.15	11.5
S	Ada	Urban	Interstate	0.27	0.14	4.52	0.87	19.6
S	Ada	Urban	Local/Residential	0.75	0.06	5.13	0.30	6.9
S	Canyon	Rural	Arterial	0.26	0.12	3.96	1.30	16.5
S	Canyon	Rural	Collector	0.28	0.16	4.06	1.18	16.2
S	Canyon	Rural	Interstate	0.22	0.19	3.30	1.60	21.0
S	Canyon	Rural	Local/Residential	0.76	0.31	5.73	1.22	9.4
S	Canyon	Urban	Arterial	0.44	0.12	6.07	1.03	14.3
S	Canyon	urban	Collector	0.56	0.30	6.74	1.80	13.3
S	Canyon	urban	Interstate	0.30	0.27	4.50	2.20	21.9
S	Canyon	urban	Local/Residential	1.32		8.88		6.7
W	Ada	Rural	Arterial	0.37	0.10	6.11	1.15	17.1
W	Ada	Rural	Collector	0.54	0.18	6.49	0.66	13.0
W	Ada	Rural	Interstate	0.32	0.17	5.55	0.89	20.7
W	Ada	Rural	Local/Residential	0.74	0.11	5.24	0.32	7.5
W	Ada	Urban	Arterial	0.60	0.16	8.68	1.30	15.0
W	Ada	urban	Collector	0.86	0.25	9.41	1.09	11.5
W	Ada	urban	Interstate	0.45	0.24	7.61	1.41	19.6
W	Ada	urban	Local/Residential	1.04	0.07	7.16	0.77	6.9
W	Canyon	Rural	Arterial	0.28	0.08	4.40	1.00	16.5
W	Canyon	Rural	Collector	0.28	0.07	4.27	0.13	16.2
W	Canyon	Rural	Interstate	0.23	0.11	4.07	0.46	21.0
W	Canyon	Rural	Local/Residential	0.58	0.20	4.62	0.21	9.4
W	Canyon	Urban	Arterial	0.53	0.14	7.34	1.39	14.3
W	Canyon	urban	Collector	0.66	0.30	8.00	1.88	13.3
W	Canyon	urban	Interstate	0.36	0.30	5.60	2.25	21.9
W	Canyon	urban	Local/Residential	1.00		6.74		6.7
Aggregate Averages								
Season	**County**	**Setting**	**Road Class**	**Emissions Potential (g/vkt/mps)**	**Standard deviation of Emissions potential**	**Emissions Factor (g/vkt)**	**Standard Deviation of Emissions Factor**	**Average Speed (mph)**
S				0.45	0.27	4.95	1.38	13.5
W				0.58	0.28	6.70	1.98	13.5
	Ada			0.53	0.26	6.09	1.93	13.3
	Canyon			0.49	0.32	5.31	1.79	13.8
S	Ada			0.42	0.20	4.78	0.95	13.3
S	Canyon			0.51	0.37	5.27	1.91	13.8
W	Ada			0.64	0.27	7.40	1.76	13.3
W	Canyon			0.47	0.26	5.34	1.67	13.8
		Rural		0.42	0.23	4.85	1.25	14.2
		Urban		0.63	0.29	6.92	1.95	12.7
			Arterial	0.39	0.17	5.84	1.98	15.8
			Collector	0.52	0.27	6.13	2.13	13.1
			Interstate	0.29	0.21	4.86	1.87	20.6
			Local/Residential	0.80	0.26	5.68	1.34	7.9

The average emissions factor is 6.7 [g/vkt] for all winter roads and 5.0 [g/vkt] for all summer roads. Differences between summer and winter are discussed at greater length in section 4.3.1. Overall, Ada County emissions factors (6.1 [g/vkt]) were higher than those for Canyon County (5.3 [g/vkt]). However, when segregated by season, Ada emissions factors are lower than Canyon in the summer (Ada-4.8 [g/vkt] vs. Canyon-5.3 [g/vkt]), with the converse being true in winter (Ada-7.4 [g/vkt] vs. Canyon-5.3 [g/vkt]). Perhaps Ada County emissions are elevated in the winter because Ada County performs road sanding during snow events either more frequently or to a greater extent than Canyon County. Rural roads exhibited lower emissions factors than urban roads (4.9 [g/vkt] vs. 6.9 [g/vkt]). Part of the discrepancy is due to rural roads having slightly higher speeds than their urban counterparts. In addition, rural roads are probably not as likely to receive as much sand prior to and during snow events. In comparing the emissions potentials among the different road classes, it is quite clear that in general, higher speed roads are cleaner than lower speed roads. For interstates, arterials, and collectors, the emissions factors also follow the same trend. However, local/residential road emissions factors are lower than would be expected based on the average speeds of those roads. It is important to note that this may be in part due to the fact that residential roads are not represented as physical entities in the Traffic Demand Model. Therefore, speeds that are associated with residential roads and are used to calculate emissions factors may be inaccurate.

4.2.2 Unpaved Roads

Figure 4-4 shows the unpaved roads that were surveyed with TRAKER. Since accurate traffic volume and speed information were not available, all unpaved roads were averaged together to obtain one emissions factor for dry conditions. The effect of precipitation on unpaved emissions is discussed in section 4.3.2. Table 4-7 shows the emissions potentials calculated for unpaved roads measured with TRAKER. The procedure for measurement and calculation is the same as for paved roads except that summer unpaved roads were surveyed using the TRAKER dilution system described in Section 3. There are some minor differences between summer and winter measurements on the same stretch of road. For example, the emissions potential for Pierce Park Dr. was 18.4 [g/vkt/mps] in the winter, and 6.3 [g/vkt/mps] in the summer. On the other hand, both the Cloverdale Farm loop and Dry Creek Road 2 exhibit similar emissions potentials in both seasons. Overall, within the uncertainties of the measurements, the average emissions potentials for dry unpaved roads do not differ between winter and summer.

4.3 TRAKER Loop

A set of roads that comprise a closed "loop" was traversed with the TRAKER repeatedly during the summer and winter field campaigns. The loop is shown schematically in Figure 4-5 and turn-by-turn directions are listed in Table 4-8. For paved roads, the TRAKER loop data allow for consideration of temporal trends in road dust emissions potentials. The TRAKER could not be used when roads were still wet after a rain event because excessive water in the inlets could compromise the accuracy of the measurement and ruin the onboard instruments. Therefore, it was not possible to examine the change in road dust emissions potential during and/or immediately after a rainstorm. However, for unpaved roads, the effect of precipitation on emissions potentials can be seen for up to two days after a rain event without causing damage to the TRAKER instruments. The effect of precipitation on unpaved road emissions potentials was examined by comparing meteorological parameters to TRAKER measurements.

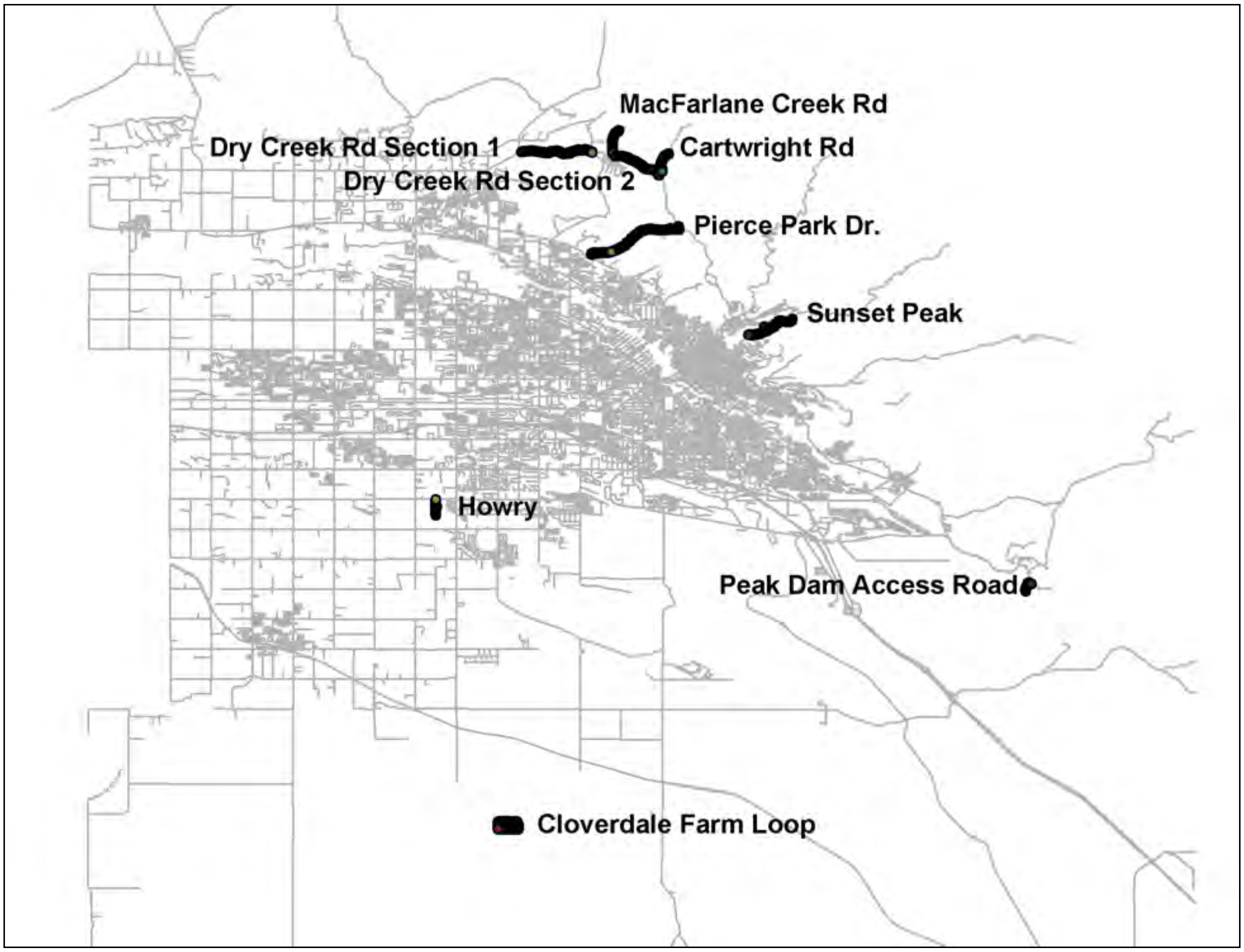


Figure 4-4. Unpaved roads surveyed during the Treasure Valley Road Dust Study. The gray lines correspond to Ada County roads and the black regions correspond to unpaved roads surveyed with TRAKER.

Table 4-7. Unpaved Roads and Corresponding Emissions Potentials

Road Surveyed	Winter Emissions Potential (g/vkt/mps)	Summer Emissions Potential (g/vkt/mps)
Cartwright		13.6
Cloverdale Farm Loop	5.8	3.5
Dry Creek 1		3.1
Dry Creek 2	6.2	6.6
Howry	6.0	
MacFarlane Creek		14.2
Pierce Park	18.4	6.3
Peak Dam Access Road		10.8
Average	9.1	8.3
Standard Error	2.8	1.8
Overall Average	8.6	
Stanadard Error	1.5	

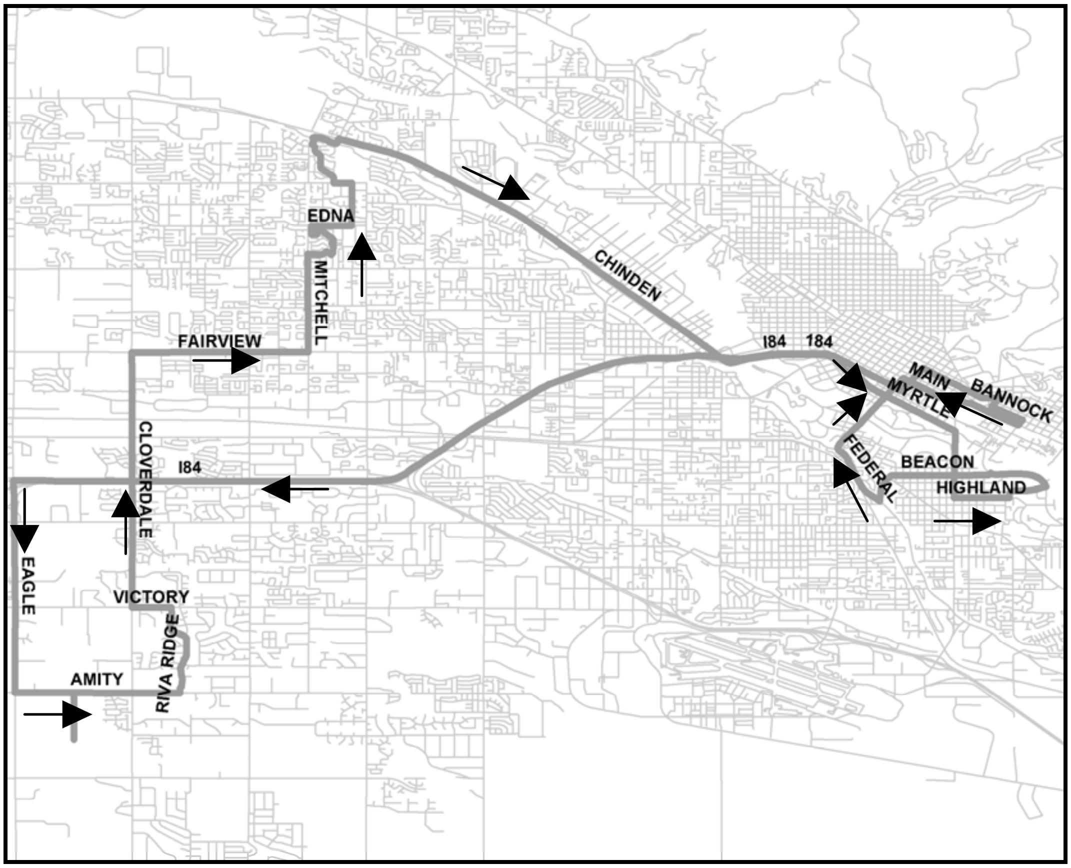


Figure 4-5. TRAKER Loop

4.3.1 Temporal Changes in Paved Road Dust Emissions

Data from the TRAKER loop are shown in Figure 4-6 as a time series of emissions potentials segregated by road class. The figure is split into a winter and a summer portion with the double vertical line delineating the two sampling seasons. Several trends are readily apparent.

First, emissions potentials are highest for residentials and lowest for interstates. Figure 4-7 shows that the road speed strongly influences the emissions potential. Thus, high-speed roads such as interstates are likely to have lower emissions potentials than lower speed roads such as collectors.

The second observation is that emissions potentials decrease steadily over time during the winter sampling period. We hypothesize that the steady decrease over the 18-day sampling period in winter is due to the slow removal of geologic material that is associated with winter conditions. The geologic material may be due to road sanding operations or carryout of mud from dirt lots or driveways.

Table 4-8. Turn-by-turn directions for TRAKER loop

Action	Approximate Distance Traveled on leg
Park Center Dr. and Mallard: Starting Point; Turn Right strip mall parking lot heading Northwest on Park Center	1 mile
Park Center Becomes Beacon	0.5 miles
Beacon Becomes Protest	0.25 miles
Rt turn onto Federal Way	0.75 miles
Rt turn on Capitol Blvd	1 mile
Rt turn onto Main St	1 mile
Main St. becomes Warm Springs Rd.	0.5 miles
Lt turn on Walnut St.	1 block
Lt turn on Bannock St.	0.25 miles
Rt turn on Bruce Ave	3 blocks
Lt on McKinley St.	2 blocks
Mckinley becomes Jefferson St.	0.25 miles
Lt on 6th St.	2 blocks
Rt on Front St.	0.75 miles
Connector to I-84 Business	1 mile
Connector becomes I-84 Business	2.5 miles
I-84 Business Turns into I-84	2.5 miles
Exit Eagle Rd. and turn Lt	2 miles
Lt on Amity Rd.	0.25 miles
Rt on Howry	0.25 miles
Reverse Direction on Howry	0.25 miles
Rt on Amity Rd.	1 mile
Lt on Riva Ridge Dr.	1 mile
Lt on Victory Rd.	0.25 miles
Rt on Cloverdale Rd.	2.5 miles
Rt on Fairview Ave.	1.2 miles
Lt on Mitchell St,	1 mile
Rt on Telfair	1000 ft
Rt on Pinedale	300 ft
Lt on Pepperwood Dr.	600 ft
Bear Rt onto Altmore Dr.	300 ft
Lt on Payson	100 ft
Rt on Gurdon	50 ft
Rt on Patton Ave.	100 ft
Rt on Edna St.	0.25 miles
Lt on Dalton Ln	0.25 miles
Lt on Mcmillan Rd.	300 ft.
Rt on Sunderland Dr.	0.4 miles
Rt on SkyCliff (maybe)	300 ft
Rt on Mountain View Dr.	0.2 miles
Lt on Garrett	50 ft
Rt on Chinden Blvd. (20/26)	4 miles
Chinden Becomes Connector	0.75 miles
Connector becomes Myrtle st.	1 mile
Rt on Broadway Ave	0.75 miles
Lt on Highland St.	0.25 miles
End TRAKER Route in Huntington Apartments Parking Lot	

Table 4-9 shows an approximate schedule and amounts of sand used during thewinter 2000-2001 season. As a matter of practice, the Ada County Highway District (ACHD) attempts to remove road sand by using street sweepers within 24 hours of application. However, authorities at the ACHD stated that due to substantial snowfall towards the end of January and beginning of February 2001, street sweepers had not been able to keep up with road sanding activities. Thus, in some areas, sand may have been present on the road surface for several weeks prior to being swept. While the road sand used by ACHD for traction control purposes is low in dust content, vehicle tires passing over coarse grains of sand may fracture and pulverize those grains into PM_{10}-sized particles. To exacerbate matters, street sweepers passing over "aged" road sand may not be as effective in removing the smaller particles resulting from pulverized sand; preliminary investigation on street sweeper effectiveness indicates that sweepers may only result in modest removal of PM_{10} –sized particles from roads (see section 4.4).

An additional source of geologic material on paved roads can result from the trackout/carryout of mud from unpaved driveways, roads, and construction sites. Since precipitation and low temperatures are more prevalent in winter, dirt lots and roads are wet for longer periods of time than in summer. Vehicles leaving muddy areas may carryout substantial amounts of mud on the tires and body unto the paved road network.

Third, summer emissions potentials are lower than those for winter and are also relatively constant over time. This indicates that by the time the summer study had begun, excess wintertime geologic material -due either to road sanding or vehicle carryout- had been removed from Ada County roads.

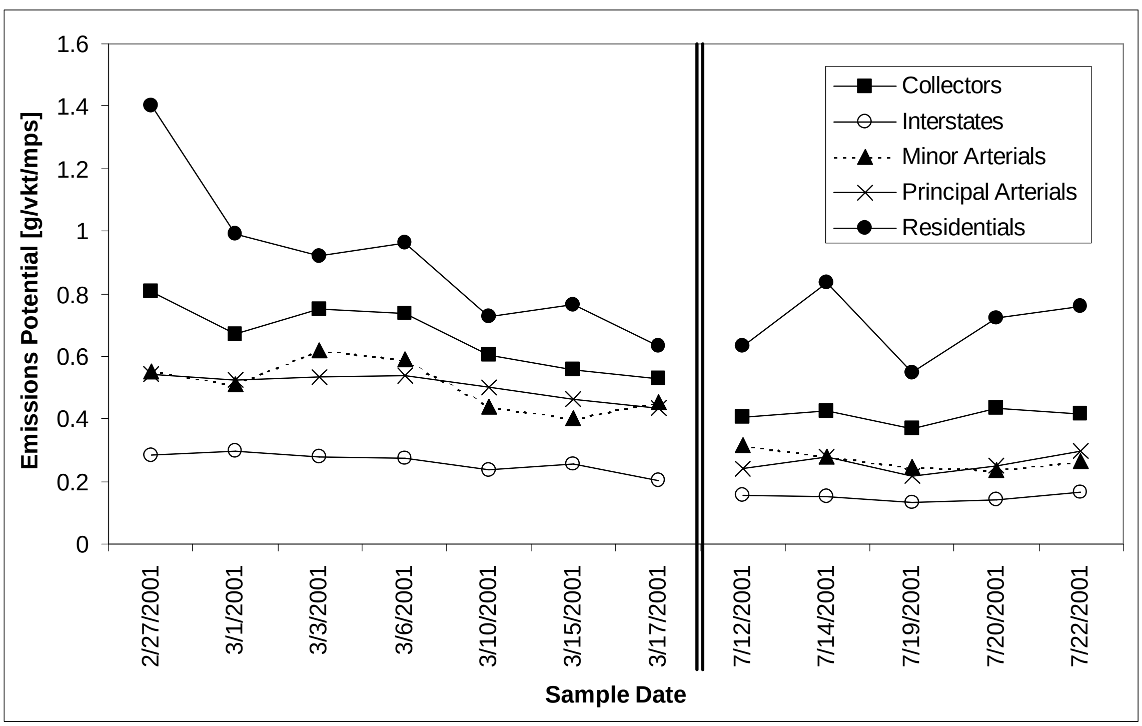


Figure 4-6. Paved road emissions potentials over time by road class. The black double vertical line indicates the end of the winter sampling and the beginning of summer sampling.

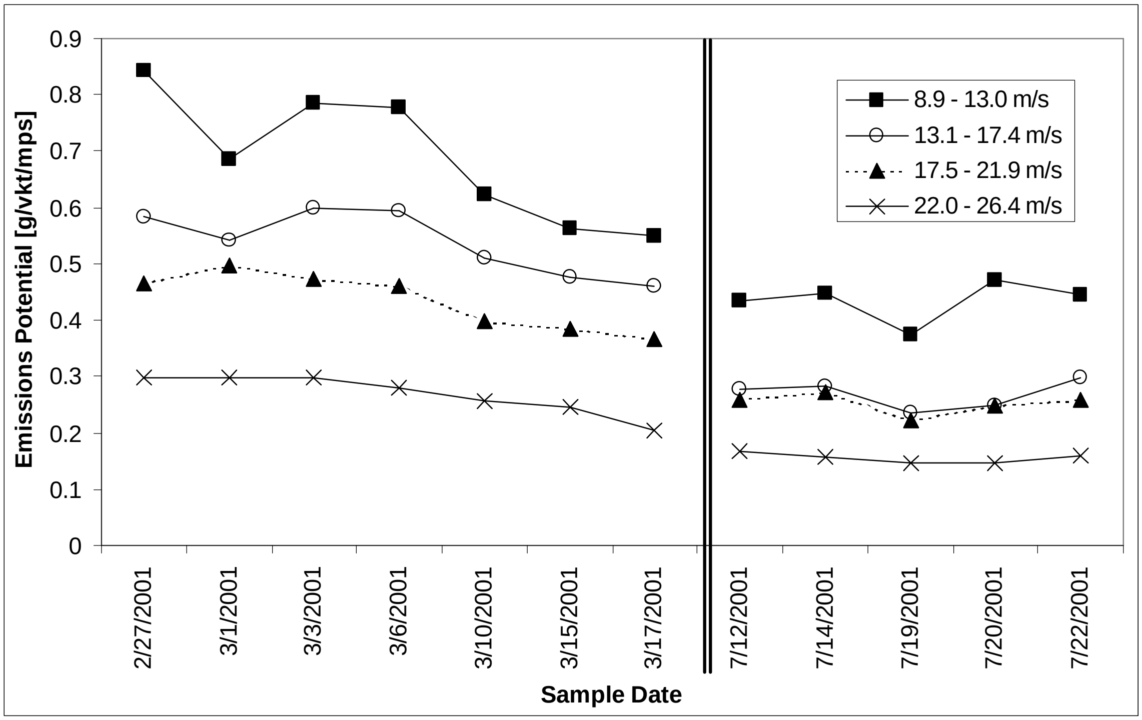


Figure 4-7. Paved road emissions potentials over time by speed class. The black double vertical line indicates the end of winter sampling and the beginning of summer sampling. Residential streets are not included in figure.

Table 4-9. Approximate schedule of sand application to Ada County roads during Winter 2000/2001

Date	Cubic meters of Sand Applied to Ada County Roads
1/13/2001	143
1/15/2001	2
1/19/2001	259
1/23/2001	5
1/25/2001	441
1/27/2001	5
1/28/2001	5
1/29/2001	301
1/30/2001	243
2/2/2001	140
2/3/2001	16
2/5/2001	7
2/10/2001	46
2/10/2001	49
2/12/2001	23
2/13/2001	4
Total 2000/2001	1688

4.3.2 Meteorological Effects on Unpaved Road Emissions

The TRAKER loop included a 1 km section of private unpaved road (Howry) that was traversed each time the loop was executed. The emissions potential for each day the loop was executed was averaged over the entire length of the unpaved road. The result appears as a time series in Figure 4-8. The black circles correspond to the emissions potential in [g/vkt/mps]. The black squares correspond to daily precipitation in mm. The gray line is a time trace of the relative humidity. Emissions potentials fall into three distinct categories outlined by the gray boxes: "dry conditions", "day after rain", and "wet conditions". The emissions potentials and daily precipitation share the same y-axis scale on the left, while the relative humidity uses the right y-axis scale. During and immediately after a rain event while the relative humidity is still high (3/3/01), emissions potentials are very low and correspond to "wet conditions". 24 hours after a rain event ("day after rain"), when the relative humidity has had a chance to subside and the top layers of soil are drying, emissions potentials are higher than under "wet conditions". 48 hours or more after a rain event, emissions potentials are even higher ("dry conditions"). If we consider the "dry conditions" as a baseline value, then under wet conditions, emissions are on average 7.9% of the baseline value and under "day after rain", emissions are 35% of their baseline values. This trend seems to hold regardless of the amount of rainfall, though we note that the range of daily rainfall amounts that were reported for the 2/23/01 to 3/20/01 period was modest (0.25 mm - 0.77 mm or 0.01 in – 0.03 in).

AP-42 (USEPA, 1999) suggests the approximation that emissions from unpaved roads should be set to zero for all days where the total daily rainfall exceeds 0.25 mm. The results of the TRAKER loop indicate that in addition to reducing emissions for days when rainfall is reported, unpaved road emissions should also be reduced for the 24-hour period that follows the day that rainfall was reported. Physically, results from the TRAKER loop suggest that a thin layer of soil at the surface dries quickly, but that the soil underneath may remain wet for at least 48 hours, considerably reducing the potential for dust emissions.

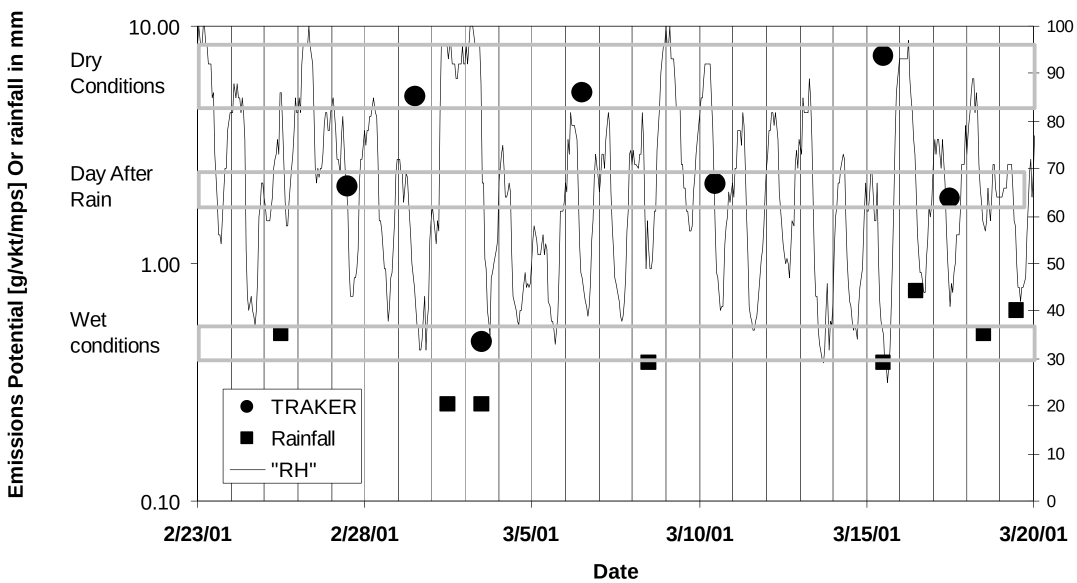


Figure 4-8. Plot of emissions potential of unpaved road on TRAKER loop, daily precipitation, and relative humidity. Emissions potentials and rainfall use the left y-axis; relative humidity uses the right y-axis.

4.4 Special Studies

During the TVRDS, experiments were carried out to determine the impact of street sweeping on paved road dust emissions. These experiments were planned and executed in coordination with Kevin Barton of the Ada County Highway District Road Maintenance (ACHD).

4.4.1 Winter Sanding Experiment

The winter sanding experiment was originally designed to collect TRAKER data from a common set of roads prior to a snowstorm event, after a snowstorm and sand application, and after the sand had been removed from the roads by street sweeping. Since, no snow events occurred in the Treasure Valley during the field study a controlled experiment was designed to measure the effects of sanding and sweeping on PM emissions.

4.4.1.1 Testing Protocol

The winter sanding experiment took place on the morning of 03/15/2001. The first test was carried out in Boise on the rightmost eastbound land on Chinden Road between 50th and 42nd St. In this area, Chinden is a principle arterial with commercial zoning on both sides of the street. The road has four traffic lanes and a turn lane in the middle. The shoulder of the road is paved and 1 meter deep in areas where there are no ingress-egress points. Traffic counts were obtained by COMPASS on 09/24/97 and reported to be 14,192 vehicles per day in one direction. The COMPASS traffic demand and forecasting model calculated year 2001 average daily traffic (ADT) of 23,392 in both directions or approximately 6,000 ADT per lane. The posted speed limit on this road is 45 mph.

The second test was performed on the westbound lane on Rose Hill/Franklin Road between Owyhee and Orchard. Rose Hill Road turns into Franklin Road west of Roosevelt. This road section has 2 traffic lanes and a turn lane. The road is in a residential neighborhood with curbing on both sides. Between 03/16/2001 4:00 (Friday) and 03/18/2001 5:00 (Sunday), DRI deployed traffic counters on the westbound section of Rose Hill 200 ft west of Owyhee. Total one-way counts were measured at 5,700 on Friday and 4,200 on Saturday with a median speed of 33.1 mph. Modeled 2001 ADT for the road was 17,910 in both directions or approximately 9,000 ADT per lane. The posted speed limit on Rose Hill/Franklin is 35 mph.

Chinden and Rose Hill/Franklin were each divided into three test sections as shown in Figure 4-9, Figure 4-10, and Table 4-10.

Table 4-10. Description of Test Section for Sweeping-Sanding Tests

Test Section	Activity	Chinden	Rose Hill/Franklin
Section 1	Sanded and swept with vacuum sweeper	Eastbound b/w 50th St. and Bradley (480 meters)	Westbound b/w Owyhee and Latah (390 meters)
Section 2	Sanded and swept with mechanical sweeper	Eastbound b/w Bradley and 45th St. (660 meters)	Westbound b/w Latah and Roosevelt (420 meters)
Section 3	Sanded but not swept	Eastbound b/w 45th St and 42nd St (600 meters)	Westbound b/w Roosevelt and Orchard (890 meters)

Figure 4-9. Map of Chinden sanding/sweeping test.

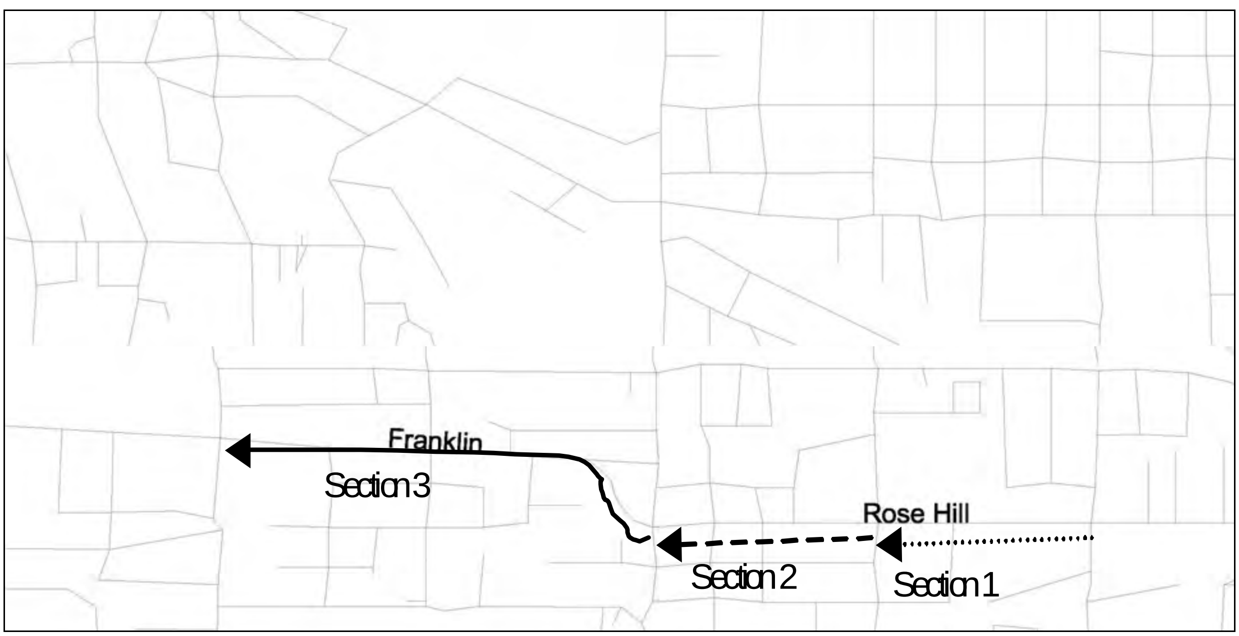


Figure 4-10. Map of Franklin/Rose Hill sanding/sweeping test.

Both roads were surveyed twice with the TRAKER vehicle immediately prior to the application of sand. After surveying, the sand truck (Figure 4-11) was operated at 5 mph over all sections of both roads. Sand flow is regulated by two controls: the gate at the bottom of the sander and the speed of the belt that moves the sand through the gate. The rate of sand flow was measured at 2.0 kg/s. The swath of sand thrown from the truck was estimated to span 6 meters in diameter.

Figure 4-11. Sand applicator truck.

Visual observations of the sand on the test sections indicated that the sand truck did not uniformly disperse the sand across the lane. The sand in the truck was wet and had a tendency to clump as it was applied. While the sand deposits were not uniform across the lane, there is no basis for presuming that any test section received more or less sand than the others.

Immediately after sanding, the vacuum sweeper (Figure 4-12) began operating on Section 1 and the mechanical sweeper (Figure 4-13) began operating on Section 2. Sweeper operators were instructed to use routine sweeping practices to collect all visible sand within their respective sections. Section 3 was used as a control and was not swept after sanding.

Figure 4-12. Elgin Whirlwind vacuum sweeper.

Figure 4-13. Johnston HSD mechanical sweeper.

Once the sand had been swept from sections 1 and 2, the TRAKER vehicle resurveyed the test sections. TRAKER surveys were repeated at several intervals after the sand was applied to evaluate how emissions from these different treatments evolve over time.

4.4.1.2 Test Results

Data were reduced by averaging the road dust PM_{10} emissions potential *b* for each test section and pass. Data from multiple passes over a test section were averaged together if the passes were made within 10 minutes of one another.

Figure 4-14 shows the results of the sanding/sweeper tests. Chinden Street (top panel) was on the TRAKER loop so data from this location was sampled on five different occasions prior to the experiment. The figures show that prior to the sanding sweeping test, the emissions potential for the three test sections from each road were similar. Emissions potential variation was less than 10% between the three test sections for both Chinden and Rose Hill/Franklin.

Ten minutes after sand application, no significant change was detected in the emissions potential from the road surface with the exception of the vacuum swept portion of Chinden. The emissions potential from this section dropped from 0.47 to 0.27 (g/vkt)/(m/s). This initial drop in potential is probably due to moisture on the road; the sand applied had an approximate moisture content of 8% (see Appendix A); the first section on Chinden received the sand that had been sitting at the bottom of the truck bed and was probably more wetted than sand that was applied later in the test (i.e on sections 2 and 3).

At 2.5 hours after sand application, the emissions potential had increased at all test sections with respect to the baseline value prior to sanding. At the Chinden test area, the vacuum swept section S1 emissions potential increased by 26%, the mechanically swept section S2 emissions potential increased by 42%, and the unswept section S3 emission potential increased by 46%. At the Rose Hill/Franklin test area; emissions potentials increased 69% on the vacuum swept section, 63% on the mechanically swept section, 61% on the unswept section.

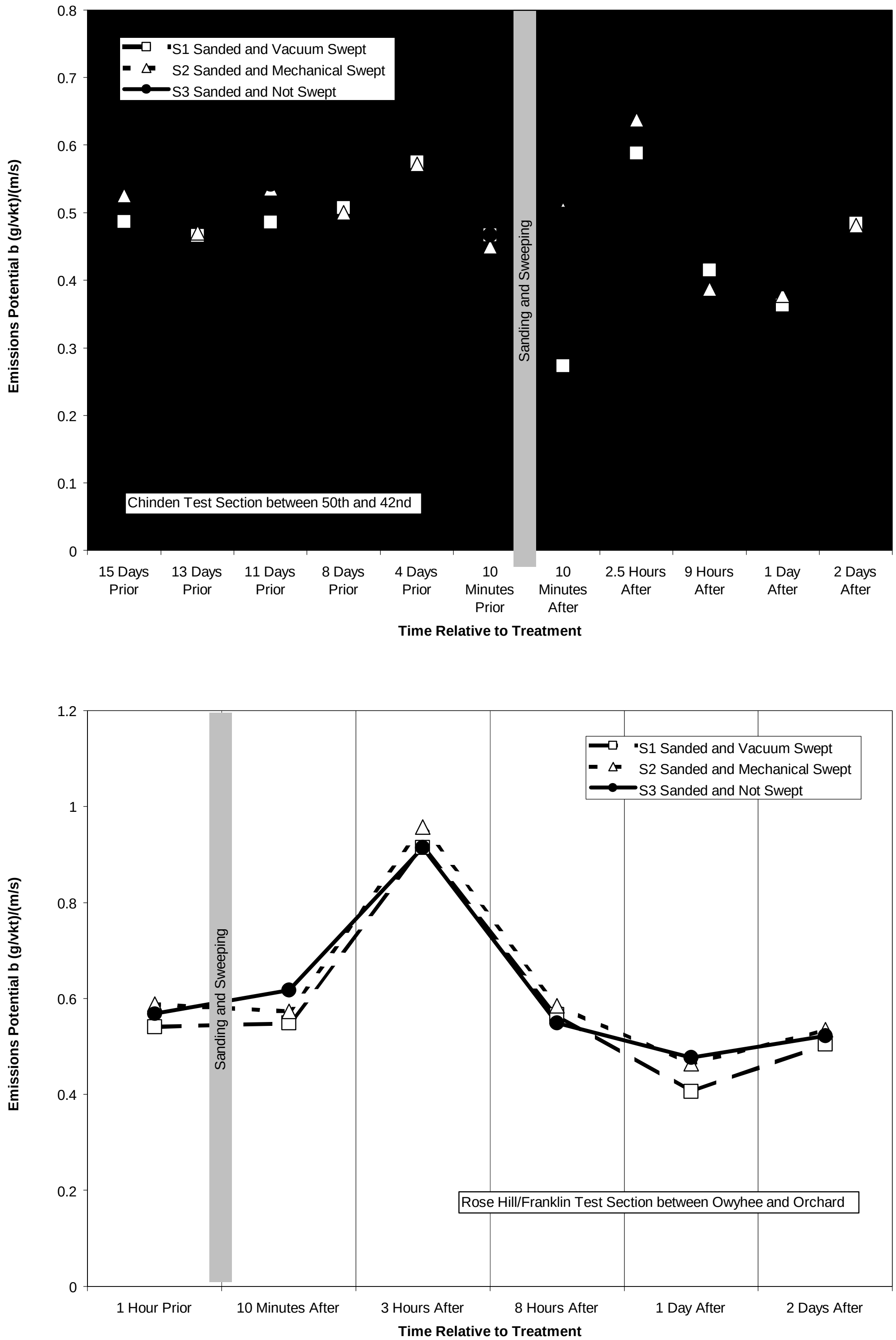


Figure 4-14. Results of controlled road sanding and sweeping tests for Chinden Road (top panel) and Rose Hill/Franklin Road (bottom panel).

Approximately 8 hours after the initial sanding and sweeping, the emissions potentials from all sections of both roads has returned to within 15% of their pretreated levels. DRI's traffic counter data from Rose Hill on 03/16/01 indicated that 40% of the measured ADT or ~2000 cars traveling at 35 mph passed over the road in the first 8 hours. Similarly, on Chinden it is estimated that 2000 to 2500 cars traveling at 45 mph passed over each lane in the first 8 hours.

Figure 4-15 shows a picture of the unswept (S3) portion of Rose Hill/Franklin one day after sand was applied. The travel lanes are clear of visible sand, however much of the material has migrated over to the untraveled portions of the road. Sand was not visible on the sections where the road had been swept using either a vacuum or mechanical sweeper.

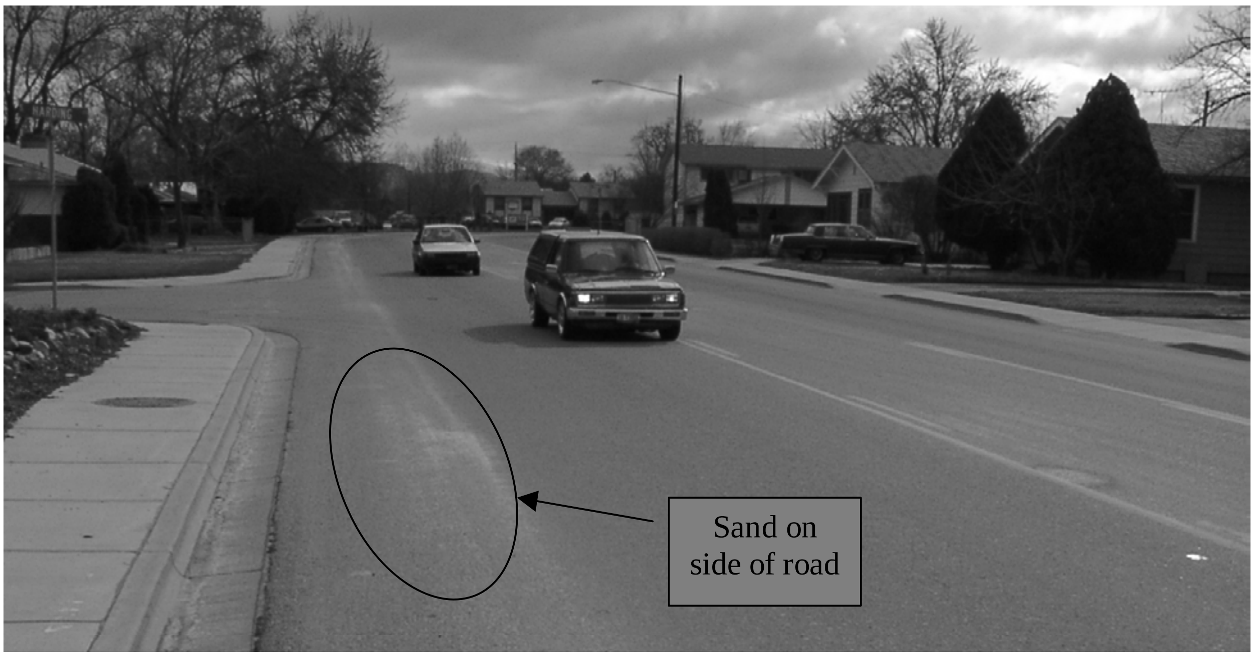


Figure 4-15. Picture of Franklin Road facing east taken 1 day after sand application. Sand material has migrated away from the traffic lanes toward the curb.

The results of the winter sanding and sweeping experiment indicate that the direct impacts of road sanding on PM_{10} emissions are short lived lasting no more than 8 hours or 2500 vehicle passes. PM_{10} emissions were observed to increase by 25% to 70% at 2.5 hours after the initial sanding and sweeping. By 8 hours after treatment, the emissions potential from the roads were indistinguishable from their pretreatment levels. Sweeping using a vacuum or mechanical system appears to provide no reduction of PM_{10} emissions potential when compared with not sweeping the road. While the sweepers did an excellent job collecting the visible sand on the roads, the systems tested were ineffective at removing the source of the PM_{10} road dust particles.

4.4.2 Summer Street-Sweeping Experiment

During the summer months, the major activity of the ACHD is chip sealing existing roadways. This process involves several steps. First the roads are swept using vacuum sweepers to remove any debris, second gravel chips are spread over the roadway and smoothed with a roller, finally a fogger is used to adhere the chips to the underlying road. The ACHD's chip sealing program provided an opportunity to test the effectiveness of street sweeping as a control to reduce road dust emissions.

Tests were conducted on 07/22/01 through 07/24/01. The TRAKER vehicle surveyed several roads before and after sweeping to evaluate the relative change in emissions potential attributable to street sweeping. Maps of the test areas are shown in Figure 4-16 and Figure 4-17. For each test section, at least three passes were made over each section immediately before and after the sweeper. The one exception is Quarter Horse that was pre-surveyed on 07/22/01 and swept and post-surveyed on 07/24/01. All streets tested were in residential neighborhoods. The sweeper used in these tests was the Elgin Whirlwind vacuum sweeper shown in Figure 4-12.

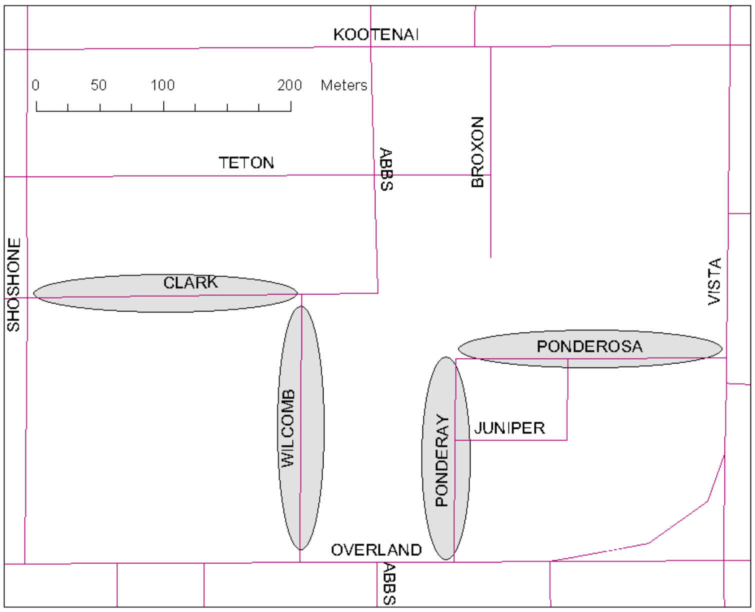


Figure 4-16. Map of street sweeper test areas in urban Boise. The shaded ovals are the areas where the sweeper tests occurred.

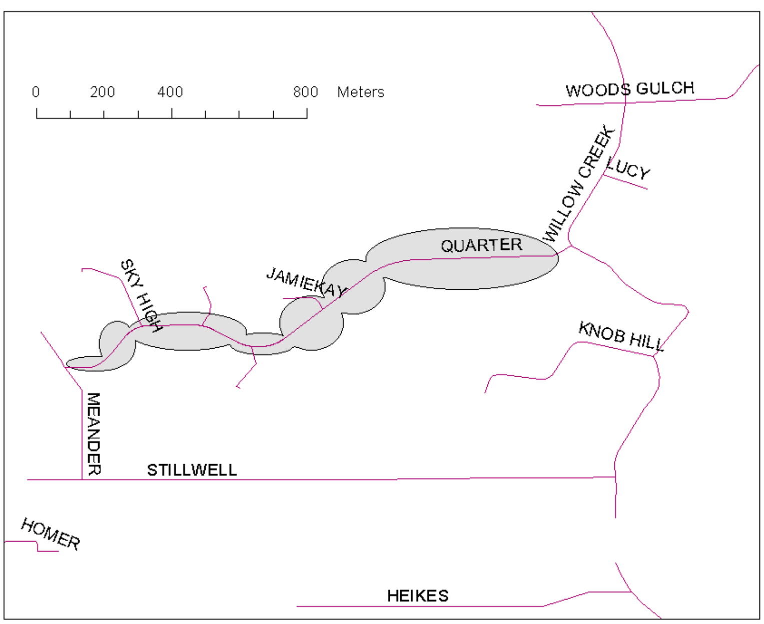


Figure 4-17. Map of street sweeper test area in rural Ada County. The shaded ovals are the areas where the sweeper tests occurred.

One-second emissions potentials (i.e. $kT^{1/3}/s$) for each road section and heading were averaged. The number of 1-second measurements constituting the averages ranged from 14 (Ponderay northbound after sweeping) to 300 (Quarter Horse westbound after sweeping). Figure 4-18 shows the average emissions potential for each road segment and heading before and after sweeping. The results from these tests are counterintuitive. If the street sweeper is removing suspendable material from the roadway, the emissions potential should decrease after sweeping. Instead, the emissions potential is observed to increase by up to 40% after sweeping. The average emissions potential increase measured on all five roads is 16%.

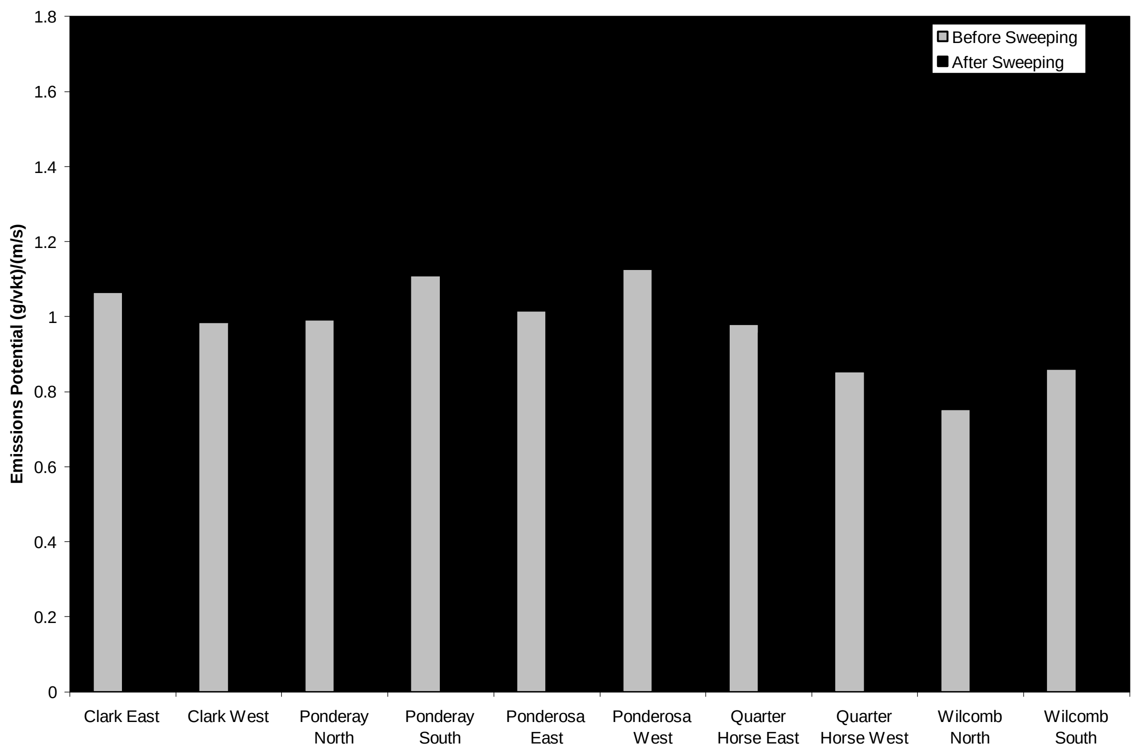


Figure 4-18. Comparison of emissions potential from 5 streets in Ada County before and after street sweeping.

The reason for the increase in emissions potential after sweeping is unclear. It is possible that material displaced from the curb unto the street as the sweeper passes over the road. Alternatively, particles trapped in the cracks and pits of the road may be redistributed across the road surface by the sweeper, making those particle available for suspension by passing vehicles.

In this experiment, the application of the sand has been shown to increase PM_{10} emissions, though only for a short time after application. Sand applied to the road drifted to the shoulders within a few hours of application. On the short timescale of these experiments, it was not possible to investigate whether or not sand blown to the side of the road can serve as a long-term reservoir for subsequent PM_{10} emissions.

At present, it is uncertain how sweeping affects the urban scale emissions inventory. The sweepers tested effectively capture large material (e.g. sand, trash, and leaf debris) but were not effective in lowering PM_{10} emissions in the short-term. We note however that the large material on roadways may be precursors to PM_{10} road dust emissions since vehicle tires can disaggregate the large material into finer particles. Thus, it is possible that the removal of comparatively large grains of geologic material reduces the total amount of PM_{10} that would otherwise be available for emission in the long-term. This mechanism, not examined by the experiments presented here, should be studied further since it may have important implications for the effectiveness of street sweeping programs in PM_{10} emissions reduction.

5. EMISSIONS INVENTORIES FOR THE TREASURE VALLEY

In this chapter, we summarize the steps taken to calculate the road dust emissions inventories for the year 2000. Specific inventories for two episodes that correspond to periods of air quality concern are also presented. Those episodes are January 1 – 9, 1991 and December 20 – 26, 1999.

We begin with a discussion of the methodology for calculating paved road emissions in section 5.1. Section 5.2 addresses unpaved road emissions calculations. The results of the emissions inventories for the Treasure Valley are summarized in 5.3 and compared to the emissions inventory prepared by SAI (1997) as well as emissions based on silt samples that were obtained as part of this study. Complete listings of the emissions inventories for year 2000, future years, and episodic periods are provided in electronic format as an appendix to this report (See Appendix C for a description of file contents).

5.1 Emissions inventory for paved roads

Emissions inventories for paved roads were carried out in several steps. First, link-level emissions potentials were calculated based on roadway characteristics that were available from the Traffic Demand Model as well as road location and setting. Next, emissions were calculated for paved roads under dry conditions, i.e. in the absence of precipitation. Results from the TRAKER portion of the study were used to estimate both PM_{10} and $PM_{2.5}$ emissions. Finally a correction was applied to account for the effect of precipitation on the emissions of road dust. Meteorological information cited here is only intended for road dust emissions calculation purposes. For a more thorough review of historical precipitation and wind conditions in the Treasure Valley, please see the document attached as Appendix B to this report.

5.1.1 Year 2000 Paved roads

5.1.1.1 Emissions potentials

For a given length of road, the emissions factor, EF, in grams per vehicle kilometer traveled ([g/vkt]) can be expressed as:

$$EF \ ? \ bs \qquad \text{Eq (5-1)}$$

where b is the emissions potential in grams per vehicle kilometer traveled per meter per second [g/vkt/mps] and s is the speed of the vehicles traveling on the length of road in meters per second ([mps]) and can be expressed as:

$$b \ ? \ C_{C,S,T} \ ?s^{?x} \qquad \text{Eq (5-2)}$$

where $C_{C,S,T}$ is a constant that depends on the county the road is in (Ada or Canyon), the setting of the road (rural or urban), and time of year (season), s is the vehicle speed, and x is an empirically-derived exponent. The emissions potential is a measure of the road "dirtiness" while the emissions factor is a measure of how much dust is emitted from a road when vehicles travel the road at a certain speed. Emissions potentials, emissions factors, and Equations 5-1 and 5-2 were discussed in Section 4; the results of that work are recapped as part of the two subsections that follow.

5.1.1.1a Roads covered by Traffic Demand Model

The Traffic Demand Model (TDM) network of roads provided by COMPASS includes a physical link for each direction of travel of each major roadway. Major roadways include “Locals”, “Collectors”, “Minor Arterials”, “Principal Arterials”, and “Interstates”. Minor streets in residential neighborhoods are not physically represented in the TDM. Emissions potential estimates for those types of roads is discussed in the next section.

For the year 2000 paved road inventory, direct TRAKER measurement results were used whenever possible. That is, when the TRAKER was used to traverse a road that corresponds to a link in the Traffic Demand Model network, the TRAKER measurement obtained on that road was used to represent the emissions potential for that link. For the remainder of the roads in the TDM, the empirical relationship expressed in equation (5-2) was used to estimate the emissions potential. Table 5-1 summarizes the empirical values used for $C_{C,S,T}$ and x. The travel speed associated with each link is reported as part of the TDM network representation.

Table 5-1. Emissions potentials for roads that are physically represented in the TDM by season, county, and setting

Season	County	Setting[a]	$C_{C,S,T}$ [g/vkt/mps]	x
S	Ada	Rural	47	-1.47
S	Ada	Urban	45	-1.39
S	Canyon	Rural	370	-2.05
S	Canyon	Urban	462	-2.03
W	Ada	Rural	43	-1.32
W	Ada	Urban	72	-1.38
W	Canyon	Rural	12	-1.05
W	Canyon	Urban	318	-1.86

[a] The setting of a road is designated based on census tract data. If a road falls into a census tract where the ratio of population to area is greater than 385 people per square kilometer, then the road setting is considered urban; otherwise, it is rural.

5.1.1.1b Residential Roads

Residential roads are not present in the TDM as physical entities. Instead, they are represented by a series of centroid connectors (Figure 5-1). In practice, this means that a small neighborhood is represented by a point, referred to as a traffic analysis zone (TAZ), and is connected to major roadways in the TDM (non-residentials) by centroid connectors. This modeling tool does not allow for direct overlay of TRAKER measurements obtained on residentials roads. Therefore, an empirical relationship between emissions potential and road speed was not possible to obtain for residential roads. The emissions potentials for residential roads are summarized in Table 5-2 and are independent of speed (i.e. x=0).

5.1.1.2 Emissions for dry paved roads

The calculation of dry paved road emissions of PM_{10} is straightforward once the emissions potentials have been calculated for the individual links in the TDM. The dry PM_{10} emissions for a link are simply:

$$E_{i,10} ? EF_{i,10} ? L_i ? V_i \qquad \text{Eq (5-3)}$$

where $E_{i.10}$ is the emissions in grams per day associatedwith link i, $EF_{i,10}$ is the emissions factor for PM_{10} for link i, L is the length of the link in kilometers, and V is the volume of traffic in vehicles per day. Substituting equation (4-3) for EF,

$$E_{i,10} ? b_i ? s_i ? L_i ? V_i \qquad \text{Eq (5-4)}$$

where b_i is the emissions potential ([g/vkt/mps]) for link i, and s_i is the speed in meters per second ([mps]). Calculation of the emissions potential, b, is described in section5.1.1.1. The speed (s), link length (L), and traffic volume (V) are provided in the TDM in units of miles per hour, miles, and vehicles per day. The link length in miles is converted to kilometers by multiplying by 1.609. The miles per hour speed is converted into units of meters per second by multiplying by 0.447. The TDM reports traffic volumes for average weekday traffic. Emissions calculated using this volume for individual days should be corrected for weekend/weekday differences as well as month to month variations. Table 5-3 shows a summary of the average weekday vkt and speeds for roads in the traffic demand model.

Table 5-2. Emissions potentials for residential roads by season, county, and setting

Season	County	Setting[a]	$C_{C,S,T}$ [g/vkt/mps]
S	Ada	Rural	0.67
S	Ada	Urban	0.76
S	Canyon	Rural	0.95
S	Canyon	Urban	1.32
W	Ada	Rural	0.77
W	Ada	Urban	1.04
W	Canyon	Rural	0.71
W	Canyon	Urban	1.00

[a] The setting of a road is designated based on census tract data. If a road falls into a census tractwhere the ratio of population to area is greater than 385 people per square km, then the road setting is considered urban; otherwise, it is rural.

Figure 5-1. Example of how centroid connectors emulate residential streets. The thin black lines represent roads in a residential neighborhood. The thick gray lines (1-4) are the representation of the residential neighborhoods within the Traffic Demand Model. The point at the center of the picture where the four gray centroid connectors meet is an example of a Traffic Analysis Zone (TZA).

Table 5-3. Speeds and VKT by county setting, and road class

County	Setting	Road Class	Speed (m/s)	Vehicle kilometers traveled (VKT)
Ada	Rural	Arterial	11.2	14129
Ada	Rural	Arterial	12.1	8692
Ada	Rural	Arterial	13.4	132011
Ada	Rural	Arterial	15.6	546380
Ada	Rural	Arterial	16.5	18753
Ada	Rural	Arterial	17.9	525237
Ada	Rural	Arterial	20.1	682971
Ada	Rural	Arterial	22.4	94776
Ada	Rural	Arterial	24.6	33173
Ada	Rural	Collector	6.7	9918
Ada	Rural	Collector	8.9	27597
Ada	Rural	Collector	9.8	1266
Ada	Rural	Collector	10.7	2972
Ada	Rural	Collector	11.2	70536
Ada	Rural	Collector	11.6	976
Ada	Rural	Collector	13.4	55059
Ada	Rural	Collector	14.3	990
Ada	Rural	Collector	14.8	718
Ada	Rural	Collector	15.6	129424
Ada	Rural	Collector	17.9	117050
Ada	Rural	Collector	19.2	340
Ada	Rural	Collector	20.1	2491
Ada	Rural	Interstate	11.2	20491
Ada	Rural	Interstate	13.4	300
Ada	Rural	Interstate	15.6	6568
Ada	Rural	Interstate	17.9	1057
Ada	Rural	Interstate	20.1	9671
Ada	Rural	Interstate	22.4	559467
Ada	Rural	Interstate	24.6	580328
Ada	Rural	Interstate	29.1	76488
Ada	Rural	Interstate	31.3	130099
Ada	Rural	Residential	6.7	335959
Ada	Rural	Residential	15.6	122594
Ada	Urban	Arterial	6.7	302
Ada	Urban	Arterial	8.9	8614
Ada	Urban	Arterial	11.2	178384
Ada	Urban	Arterial	12.1	912
Ada	Urban	Arterial	12.5	3146
Ada	Urban	Arterial	13.4	729400
Ada	Urban	Arterial	14.3	1767
Ada	Urban	Arterial	14.8	9526
Ada	Urban	Arterial	15.6	1779624
Ada	Urban	Arterial	17.0	99489
Ada	Urban	Arterial	17.9	347787
Ada	Urban	Arterial	20.1	221046
Ada	Urban	Arterial	22.4	202025
Ada	Urban	Collector	6.7	6046
Ada	Urban	Collector	8.9	90497
Ada	Urban	Collector	11.2	129329
Ada	Urban	Collector	12.5	8532
Ada	Urban	Collector	13.4	207869
Ada	Urban	Collector	14.3	4538
Ada	Urban	Collector	14.8	3604
Ada	Urban	Collector	15.6	96937
Ada	Urban	Interstate	11.2	34479
Ada	Urban	Interstate	13.4	86

County	Setting	Road Class	Speed (m/s)	Vehicle kilometers traveled (VKT)
Ada	Urban	Interstate	15.6	5498
Ada	Urban	Interstate	17.9	384
Ada	Urban	Interstate	20.1	25571
Ada	Urban	Interstate	22.4	630377
Ada	Urban	Interstate	24.6	365955
Ada	Urban	Interstate	29.1	32482
Ada	Urban	Interstate	31.3	54620
Ada	Urban	Residential	6.7	461580
Ada	Urban	Residential	8.9	506
Ada	Urban	Residential	11.2	7796
Ada	Urban	Residential	13.4	8186
Ada	Urban	Residential	15.6	7736
Canyon	Rural	Arterial	11.2	36654
Canyon	Rural	Arterial	13.4	79192
Canyon	Rural	Arterial	15.6	458524
Canyon	Rural	Arterial	17.9	271031
Canyon	Rural	Arterial	20.1	223330
Canyon	Rural	Arterial	22.4	54727
Canyon	Rural	Collector	8.9	3502
Canyon	Rural	Collector	11.2	15248
Canyon	Rural	Collector	13.4	91027
Canyon	Rural	Collector	15.6	68303
Canyon	Rural	Collector	17.9	269868
Canyon	Rural	Collector	20.1	52287
Canyon	Rural	Interstate	11.2	27211
Canyon	Rural	Interstate	22.4	318399
Canyon	Rural	Interstate	24.6	251742
Canyon	Rural	Interstate	26.8	184881
Canyon	Rural	Interstate	29.1	61716
Canyon	Rural	Residential	6.7	248516
Canyon	Rural	Residential	8.9	8146
Canyon	Rural	Residential	11.2	1300
Canyon	Rural	Residential	13.4	10827
Canyon	Rural	Residential	15.6	39833
Canyon	Rural	Residential	17.9	44371
Canyon	Rural	Residential	20.1	14220
Canyon	Urban	Arterial	8.9	1580
Canyon	Urban	Arterial	11.2	19537
Canyon	Urban	Arterial	12.5	2136
Canyon	Urban	Arterial	13.4	167150
Canyon	Urban	Arterial	15.6	406269
Canyon	Urban	Arterial	17.9	34744
Canyon	Urban	Collector	8.9	18628
Canyon	Urban	Collector	11.2	2593
Canyon	Urban	Collector	13.4	6346
Canyon	Urban	Collector	15.6	22598
Canyon	Urban	Interstate	11.2	14488
Canyon	Urban	Interstate	24.6	139998
Canyon	Urban	Interstate	26.8	59369
Canyon	Urban	Interstate	29.1	77983
Canyon	Urban	Residential	6.7	84948

Note that for residential roads, there is an implicit assumption that the length of the link and the volume of traffic on the centroid connector approximate the total travel on residential roads represented by the connector. Taking Figure 5-1 as an example, the assumptionimplicit to the emissions calculation is that the vehicle kilometers traveled on residential roads within the rectangle ABCD are equal to the vehicle kilometers traveled on the TDM links 1,2,3, and 4.

5.1.1.2a PM_{10} and $PM_{2.5}$ Correlation

Emissions factors for $PM_{2.5}$ were assumed to be a constant proportion of the PM_{10} emissions factors (See section 4.1.3 for details). For paved roads, PM_{10} emissions factors were multiplied by 0.057 to obtain $PM_{2.5}$ emissions factors.

5.1.1.3 Accounting for precipitation

AP-42 (USEPA, 1999) does not prescribe a strategy for accounting for the reduction of road dust emissions due to rain. However, it is clear, both by casual observation and by analogy to unpaved roads, that emissions of paved road dust must be discounted to account for precipitation. Because TRAKER instruments are sensitive to moisture, it was not possible to directly measure road dust emissions during, or even shortly after a rain event. In the absence of a known precedence, a conservative engineering guess was applied. The engineering approach was based on the observation that after even a brief rain shower (corresponding to between 0..25 mm to 0.50 mm of rain), roads remain visibly wet for approximately one hour. Moisture in the asphalt matrix may retard emissions even after the road "looks" dry. As a conservative approach, paved road dust emissions were assumed to be 0 for 30 minutes for each 0.25 mm of precipitation. No attempt was made to differentiate between the effects of snowfall and rainfall for paved roads since no supporting data are available.

Table 5-4 shows the distribution of precipitation by month for the Treasure Valley area. To obtain the fraction of time paved road emissions are zero, for each month, the average daily precipitation is multiplied by 0.5 hours and divided by 24 hours. To obtain actual monthly emissions, the dry paved road emission rate is multiplied by 1-(fraction of time paved road emissions are zero). For example, for January, paved road emissions would be calculated by multiplying the dry emission rate by 1-0.10 = 0.90.

Table 5-4. Summary of precipitation statistics by month, Boise airport January 1940-October 2001.

Month	Fraction of days with 0.25 mm or more precipitation	Average daily precipitation (mm)	Average daily precipitation when >0	Fraction of time Paved Road emissions are zero
Jan	0.38	1.17	0.12	0.10
Feb	0.36	1.04	0.11	0.09
Mar	0.31	1.02	0.13	0.08
Apr	0.28	1.02	0.15	0.08
May	0.25	1.04	0.16	0.09
Jun	0.20	0.74	0.15	0.06
Jul	0.08	0.23	0.11	0.02
Aug	0.08	0.23	0.12	0.02
Sep	0.12	0.51	0.16	0.04
Oct	0.19	0.66	0.14	0.05
Nov	0.34	1.14	0.13	0.09
Dec	0.37	1.12	0.12	0.09
Annual	0.25	0.81	0.13	0.07

5.1.1.4 Winter average and annual average emissions

Winter emissions for the year 2000 inventory were calculated based on the winter emissions potentials shown in Table 5-1 and Table 5-2. Precipitation data for the months of

January, February, and March were used to account for the effects of precipitation on road dust emissions.

Yearly average emissions were calculated by applying the summer emissions potentials in Table 5-1 and Table 5-2 to all non-Winter (i.e. not January, February, or March) months. The effect of precipitation for each non-winter month was weighted by the number of days in that month. The average emissions per day for winter were multiplied by the number of days (90) and added to the average emissions per non-winter day multiplied by the number of days (275). The total was divided by 365 to arrive at an annual-average emissions inventory.

5.1.2 Future year paved road emissions

Emissions inventories for future years were calculated similarly to the year 2000. Traffic Demand Model results for the years 2010, 2015, and 2020 were combined with emissions potentials to obtain emissions factors on a link-by-link basis. Since no actual TRAKER data are available for future years, the emissions potentials for future year inventories were exclusively calculated by equation (5-2) and Table 5-1 and Table 5-2. Note that the road setting (urban/rural) was re-evaluated for each link in the TDM for each year. The future year populations for individual census tracts were calculated by summing the number of houses in each Traffic Analysis Zone that is contained within the tract and scaling with year 2000 populations. This approach assumes that the number of people per household remains constant between the year 2000 and all future years. A map delineating the urban/rural zones for each of the TDM years modeled is shown in Figure 5-2. For precipitation corrections, the historical average correction factors shown in Table 5-4 were used.

5.1.3 Episodic paved road emissions

In addition to the years, 2000, 2010, 2015, and 2020, daily emissions inventories were also assembled for January 1-9, 1991 and December 20-26, 1999. For days without precipitation, winter dry paved roads emissions were used. For days with precipitation, for each 0.25mm 30 minutes of zero emissions were assumed. The total number of hours of zero emissions for a given day was calculated, subtracted from 24, and then divided by 24 to give a precipitation modifier ratio. This ratio was then multiplied by the dry paved road emissions rate to give the paved road emissions for that day.

5.1.3.1 December 20 –26, 1999

Because of the episode’s proximity to the beginning of the year 2000, year 2000 TDM results were used to calculate daily dry paved road emissions rates.

5.1.3.2 January 1 – 9, 1991

For the January 1-9, 1991 episode, the dry paved emissions were estimated from the year 2000 Traffic Demand Model network. The total vehicle miles traveled (VMT) in 1991 were estimated by regressing the year 2000, 2010, 2015, and 2020 Total VMTs (see Figure 5-3). The VMT for 1991 (6.77 million miles) was then divided by the VMT for 2000 (8.79 million miles) to arrive at a correction factor for 1991 dry paved emissions. Based on this analysis, 1991 dry paved emissions were 77.1% of 2000 dry paved emissions.

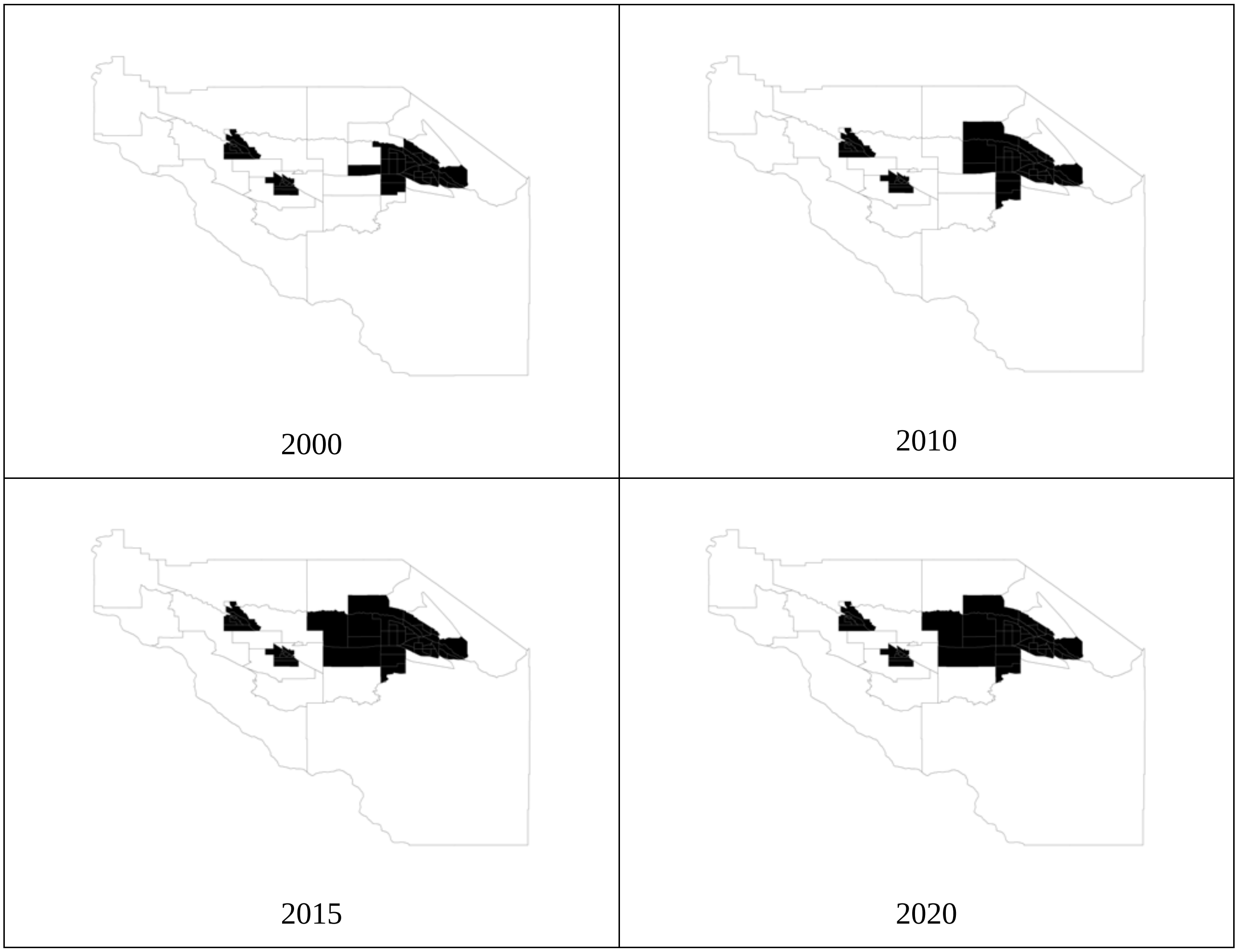


Figure 5-2. Maps of urban/rural zones for year 2000 and future year emissions potentials calculations. Urban areas are represented by census tracts shaded in black; tracts in rural areas are white. A census tract is designated as "urban" if the average population density within the tract >= 1000 per square mile.

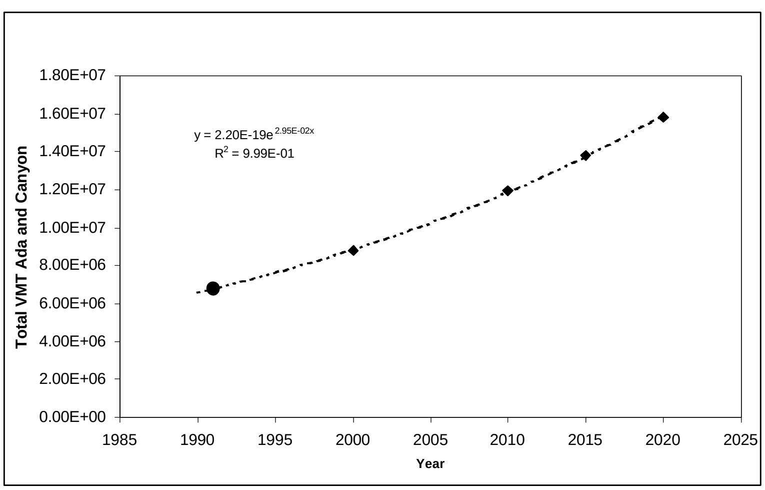


Figure 5-3. VMT growth rate over time. The black diamonds are data from Traffic Demand Models for the years 2000, 2010, 2015, and 2020. The dashed line is an exponential fit to the black diamonds and represents the increase of VMT with calendar year. The black circle is an estimate of VMT for 1991 based on the fit.

5.1.3.2a January 1 – 9, 2000, 2010, 2015, 2020

Meteorological conditions for the January 1 – 9, 1991 episode were used in conjunction with year 2000, 2010, 2015, 2020 TDM data to calculate hypothetical emissions for those years.

5.2 Emissions inventory for unpaved roads

Unpaved roads are generally not as well-documented as their paved counterparts. In particular, there is little information about the speed of travel, length, and exact location of unpaved roads. In the absence of this information, it is not possible to calculate separate emissions potentials for unpaved roads based on their attributes. Therefore, a single dry emissions potential value (8.58 g/vkt/mps) representing all unpaved roads sampled with the TRAKER during the Treasure Valley Road Dust Study was used for assembling emissions inventories. A constant speed of 11.2 mps (25 mph) was used for all unpaved roads. In sections 5.2.1 and 5.2.2, we describe how the activity-levels were estimated for unpaved roads in Ada and Canyon Counties, respectively. Section 5.2.3 details the correction to the dry emissions rate based on precipitation effects. The emissions inventory for paved roads was calculated on a link level basis. Since most unpaved roads are not associated with links in the Traffic Demand Model network, emissions from unpaved roads were distributed over the network links as a means of "spreading them out" over the Treasure Valley. The procedure used for this approach is described in section 5.2.4.

5.2.1 Accounting for unpaved roads in Ada County

A list of unpaved roads in Ada County, including their lengths, estimated vehicle speed, and estimated VKT was provided by COMPASS. The roads were also characterized as either rural or urban.

Table 5-5. Unpaved Roads in Ada County. Numbers in bold are estimated.

County	Urban/Rural	km	VKT	Ave_Speed m/s
Ada	Urban	116	16,712	**11.2**
Ada	Rural	26.1	1,896	**11.2**

5.2.2 Accounting for unpaved roads in Canyon County

In addition to having two major urban areas, Nampa and Caldwell, Canyon County also has several small population centers that in turn have unpaved roads associated with them. Accounting of unpaved roads in Canyon County involved using surrogates to estimate road lengths and VMT's for urban and rural areas as well as estimating unpaved road lengths and VMT's for small townships.

Estimates of rural and urban unpaved roads for Canyon County were based on data from Ada County. 1997 population was used as a surrogate to estimate Canyon County roads. The number of miles per population was calculated for both urban and rural areas of Ada County (see Table 5-6). It was assumed that the lengths of unpaved roads per population in urban and rural areas were the same for Ada and Canyon Counties. The resulting estimates of vehicle kilometers traveled are shown in Table 5-6. Data for Ada County are based on unpaved roads listing provided by COMPASS. For Canyon County unpaved road lengths per unit population were assumed to be the same as for Ada County. Total urban and rural lengths for Canyon County were calculated based on population. The numbers in bold italics correspond to estimated values.

Table 5-6. Unpaved Roads in km for urban and rural areas of Ada and Canyon Counties.

County	Setting	Unpaved Roads in km	Population in thousands	Km of Unpaved Road per 1000 people
Ada	Rural	26.1	64.8	0.40
Ada	Urban	116	201	0.58
Canyon	Rural	***20.7***	51.4	***0.40***[a]
Canyon	Urban	***33.4***	57.9	***0.58***[a]

[a] Canyon County estimates of unpaved road length per population are based on Ada County data.

Table 5-7. Vehicle Kilometers Traveled on unpaved Roads in rural and urban portions of Canyon County. Numbers in bold are estimates.

County	Urban/Rural	Km	ADT	VKT	Ave_Speed mps
Canyon	Urban	33.4	**120**	4,004	**11.2**
Canyon	Rural	20.7	**120**	2,488	**11.2**

In addition to the two broad categories, "rural" and "urban", there were unpaved roads in Canyon County that were associated with small rural townships. A list of those is provided inTable 5-8. Data were only available for the Goldengate Highway District which covers the Wilder and Greenleaf townships. Based on the total km of roads inventoried in the Goldengate townships (51.3) and the populations of Greanleaf and Wilder (1880), a length of unpaved road per unit population was calculated to be (82.5 km/ 1880) = 0.044 km/person. This ratio was used to estimate the lengths of unpaved roads associated with the townships shown in Table 5-8. Average daily traffic (ADT) was conservatively estimated as 20 vehicles per day.

Table 5-8. Estimates of km of unpaved roads, average daily traffic, and vehicle speeds for small townships in Canyon County. Numbers in bold are estimates.

Township	1997 Population	Unpaved roads (km)	Average Daily Traffic	Vehicle kilometers traveled	Speed (m/s)
Wilder	1232	**55**	**20**	1083	**11.2**
Greeanleaf	648	**29**	**20**	570	**11.2**
Notus	380	**16**	**20**	334	**11.2**
Parma	1597	**71**	**20**	1404	**11.2**
Middleton	1851	**82**	**20**	1627	**11.2**
Melba	252	**11**	**20**	221	**11.2**

5.2.3 Accounting for precipitation effects on unpaved road dust emissions

The effect of meteorology on unpaved road emissions was considered in terms of ground snow cover and precipitation. On days when there was snow cover on the ground, unpaved road emissions were set to zero. On days when precipitation was observed, the emissions potential for dry unpaved roads was multiplied by 0.079 to obtain emissions. For days immediately after a day when precipitation was observed, the dry emissions potential was multiplied by 0.35 in order to arrive at the emissions potential for that day. This treatment of precipitation followed directly from the results of the TRAKER loop data that were summarized in Chapter 5. The loop data showed that when the ground was wet, emissions were 7.9% of their dry value. The day after a precipitation event, emissions were still only 35% of their dry values. The average year, based on historical data between 1940 and 2000, contains 13.2 days where snow cover is present. For the purposes of emissions inventories, it was assumed that all these days occur during the winter. 79.6 days per year contain measurable precipitation while there is no snow cover present on the ground. On 10.6 days out of the year, both precipitation and snow cover are observed. The breakdown of the various conditions is shown inTable 5-9.

Table 5-9 Precipitation and snow cover summary based on data from Boise airport (1940-2000)

Month	Days in Month	Fraction of all days with precipitation 0.25 mm or greater	Number of Days with 0.25 mm or more precipitation	Number of Days with snow cover present but no measurable precipitation	Number of Days with snow cover present and measurable precipitation	Modified number of Days with precipitation excluding days when both precipitation and snow cover are observed	Modified Fraction of all days with precipitation
Jan	31	0.13	11.78	4.54	3.65	7.82	0.10
Feb	28.25	0.11	10.17	4.14	3.32	6.75	0.09
Mar	31	0.11	9.61	4.54	3.65	6.38	0.08
Apr	30	0.09	8.4	0	0	8.40	0.11
May	31	0.09	7.75	0	0	7.75	0.10
Jun	30	0.07	6	0	0	6.00	0.08
Jul	31	0.03	2.48	0	0	2.48	0.03
Aug	31	0.03	2.48	0	0	2.48	0.03
Sep	30	0.04	3.6	0	0	3.60	0.05
Oct	31	0.07	5.89	0	0	5.89	0.07
Nov	30	0.11	10.2	0	0	10.20	0.13
Dec	31	0.13	11.47	0	0	11.47	0.14

The precipitation persistence history for the Treasure Valley was used to estimate the number of precipitation days and the number of "Day After Precipitation" Days (see Table 5-10). To calculate the annual reduction due to consecutive precipitation days, an effective emissions modifier was calculated as:

Frequency of occurrence ? {(# precip days ? 0.079) + 1?0.35}/(# precip days+1)

Annual basis reduction in emissions was distributed among the months according to the number of days of precipitation in each month. Table 5-11 contains the final multipliers for calculating Winter and annual emissions from dry unpaved emissions potentials.

Table 5-10. Summary of precipitation persistence (consecutive days).

Consecutive days with precipitation	Number of occurrences (1940-2001)	Total Days	Occurrences per year	Days per year
16	1	16	0.02	0.26
15	1	15	0.02	0.24
13	1	13	0.02	0.21
12	2	24	0.03	0.39
11	2	22	0.03	0.36
10	1	10	0.02	0.16
9	4	36	0.06	0.58
8	12	96	0.19	1.55
7	22	154	0.36	2.49
6	34	204	0.55	3.30
5	85	425	1.37	6.87
4	163	652	2.63	10.53
3	310	930	5.01	15.03
2	742	1484	11.99	23.98
1	1474	1474	23.82	23.82
0	17049	17049	275.47	275.47

Table 5-11. Table of modifiers for snow cover and precipitation

Month	Fractional discount due to snow	Fractional discount due to precipitation effects	Total fractional discount	Dry emissions multiplier
Jan	0.118	0.120	0.237	0.763
Feb	0.118	0.113	0.231	0.769
Mar	0.118	0.098	0.215	0.785
Apr	0.000	0.133	0.133	0.867
May	0.000	0.119	0.119	0.881
Jun	0.000	0.095	0.095	0.905
Jul	0.000	0.038	0.038	0.962
Aug	0.000	0.038	0.038	0.962
Sep	0.000	0.057	0.057	0.943
Oct	0.000	0.090	0.090	0.910
Nov	0.000	0.161	0.161	0.839
Dec	0.000	0.176	0.176	0.824

For the Jan 1-9, 1991 episodes and the December 20-26, 1999 episodes unpaved road emissions were calculated based on daily precipitation for those days. There was 180 to 200 mm of snow cover for the entire January 1-9, 1991 period. In addition trace amounts of snowfall were recorder for 1/3/91, 1/5/91, 1/8/91, and 1/9/91, and 30 mm of snowfall was recorder for 1/7/91. Based on the snow cover, unpaved road emissions were zero for the entire January 1-9, 1991 episode. There was no snow cover present for any of the days December 20-26, 1999. Traces of precipitation were reported for two hours on 12/24/99 at the Boise airport. Traces of precipitation were reported for 11 hours on 12/25/99 and 10 hours on 12/26/99. 12/25/99 and 12/26/99 were treated as precipitation days, while 12/24/99 was treated as a "Day after precipitation" day.

5.2.4 Attribution of unpaved road dust to links in existing Traffic Demand Model network

Unpaved road locations were not available in electronic format for either Ada or Canyon Counties. The emissions from unpaved roads were distributed over the Traffic Demand Model network by County and by setting (urban vs. rural). Centroid connectors, interstates, and local roads were assigned zero unpaved road dust emissions. For the remainder of the links-collectors, minor arterials, and principal arterials-for each county and setting, the unpaved road emissions were attributed equally to the links based on the length of the link. For example, rural Ada unpaved emissions were attributed to the links in rural Ada County (not including centroid connectors, interstates, and locals). If link "A" was twice a s long as link "B", then the unpaved road dust emissions attributed to link "A" were twice as high as those attributed to link "B". This method is clearly only an approximation of the spatial distribution of unpaved road emissions.

For the small townships shown in Table 5-8, all unpaved road dust emissions associated with the township were attributed to the link in the Traffic Demand Model that was physically closest to the township.

5.3 Results of road dust emissions inventories

Paved and unpaved road dust emissions inventories were assembled for winter conditions and annual average conditions for the years 2000, 2010, 2015, and 2020. Daily episode-specific inventories were also assembled for January 1 – 9, 1991 and December 20 – 26, 1999. All the complete link-level emissions inventories are presented in an electronic format described in an appendix to this report. In this section, we summarize the characteristics of the emissions inventories and compare them to both prior work, and emissions calculated using the AP-42 silt loading method.

5.3.1 Paved Roads

Table 5-12 shows the paved road dust emissions on an average winter day and average annual emissions for year 2000 as well as for future years. Average winter emissions (81.2 tons per day) for the year 2000 are 31% higher than average annual emissions (62.0 tons per day). On an annual average basis, 46.4 tons per day originate from Ada County, accounting for approximately 75% of the paved road dust emissions in the Treasure Valley. Annual average emissions increase in future years over year 2000 emissions by 26%, 42%, and 58% for the years 2010, 2015, and 2020, respectively. Table 5-13 shows that the majority of emissions emanate from roads classified as arterials (57.9% of total on annual average basis). Collectors, interstates and locals each contribute 11.8%, 19.0% and 11.3% of the total paved road emissions, respectively.

Table 5-12. Year 2000, 2010, 2015, and 2020 paved road dust emissions by County and Setting

Year	County	Setting	Average Winter Day Paved Road Dust Emissions (metric tons/day)	Annual Average Daily Paved Road Dust Emissions (Metric tons/day)
2000	Ada	Rural	21.7	16.5
2000	Ada	Urban	42.2	30.0
2000	Canyon	Rural	11.0	10.1
2000	Canyon	Urban	6.2	5.5
2000	**Ada**	**All**	**64.0**	**46.4**
2000	**Canyon**	**All**	**17.2**	**15.6**
2000	**Ada & Canyon**	**All**	**81.2**	**62.0**
2010	Ada	Rural	22.1	16.8
2010	Ada	Urban	58.3	41.8
2010	Canyon	Rural	14.4	13.1
2010	Canyon	Urban	7.2	6.6
2010	**Ada**	**All**	**80.4**	**58.6**
2010	**Canyon**	**All**	**21.6**	**19.7**
2010	**Ada & Canyon**	**All**	**102.0**	**78.2**
2015	Ada	Rural	17.1	13.0
2015	Ada	Urban	74.5	53.4
2015	Canyon	Rural	16.1	14.6
2015	Canyon	Urban	8.0	7.3
2015	**Ada**	**All**	**91.6**	**66.4**
2015	**Canyon**	**All**	**24.1**	**21.9**
2015	**Ada & Canyon**	**All**	**115.7**	**88.3**
2020	Ada	Rural	19.1	14.6
2020	Ada	Urban	82.0	58.7
2020	Canyon	Rural	18.1	16.6
2020	Canyon	Urban	9.0	8.3
2020	**Ada**	**All**	**101.1**	**73.3**
2020	**Canyon**	**All**	**27.2**	**24.8**
2020	**Ada & Canyon**	**All**	**128.3**	**98.2**

The distributions of paved road dust emissions are shown in Figure 5-4. Emissions from individual links have been normalized with the length of the link. Dark lines indicate higher per kilometer of road emissions than light colored lines. The figure shows that the large sources of paved road dust are concentrated in the urban parts of Ada and Canyon Counties as well as the interstates.

Table 5-13. Year 2000 Paved Road Dust Emissions by Road Class

Road Class	Average Winter Day Paved Road Dust Emissions (metric tons/day)	Road Class percent of Winter Emissions	Annual Average Daily Paved Road Dust Emissions (Metric tons/day)	Road Class percent of Annual Emissions
Arterial	48.0	59.1	35.9	57.9
Collector	9.2	11.3	7.3	11.8
Interstate	16.5	20.4	11.8	19.0
Local/Residential	7.5	9.2	7.0	11.3

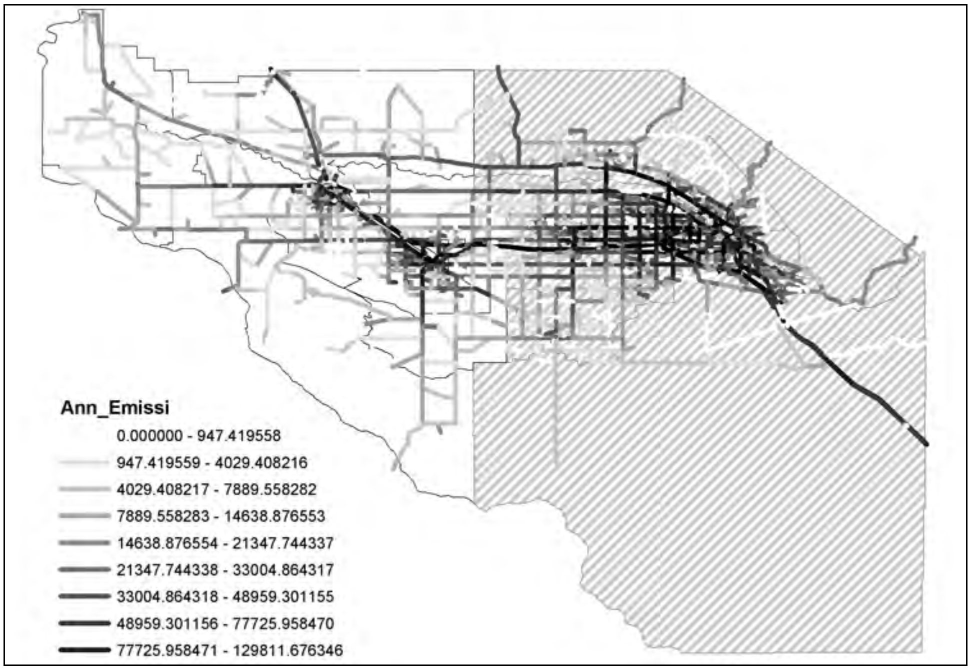


Figure 5-4. Map of distributions of road dust emissions. Emissions per link have been normalized with the length of the link. The units of the numbers in the legend are grams per day per km of link. Darker lines correspond to links with higher emissions on a per kilometer basis.

5.3.2 Unpaved Roads

Unpaved Road Emissions For the Treasure Valley are summarized inTable 5-14. Note that actual emissions were assumed to be constant between the years 2000 and 2020. However, in distributing the emissions to the Traffic Demand Model links (see section5.2.4 for clarification), the respective TDM network associated with each year was used. Effectively, this moves emissions from the links that exist in the TDM for the year 2000 to the new links in the network for the years 2010, 2015, and 2020. An example of the unpaved road dust emissions distribution isshown in Figure 5-5.

Table 5-14. Distributions of average winter day and average annual-basis day unpaved road emissions in the Treasure Valley for years 2000-2020.

County	Urban/Rural	Km of Unpaved Roads	Daily Dry Emissions (metric tons/day)	Average Winter Day (metric tons /day)	Average Day on Annual Basis (metric tons/day)
Ada	Urban	116	1.60	1.24	1.39
Ada	Rural	26	0.18	0.14	0.16
Canyon	Urban	33	1.78	1.38	1.55
Canyon	Rural	21	0.38	0.30	0.33
Canyon	Wilder	54	0.24	0.18	0.21
Canyon	Greeanleaf	28	0.62	0.48	0.54
Canyon	Notus	17	0.10	0.08	0.09
Canyon	Parma	70	0.05	0.04	0.05
Canyon	Middleton	81	0.03	0.02	0.03
Canyon	Melba	11	0.13	0.10	0.12
Canyon	All townships	262	0.16	0.12	0.14
Canyon	Urban & Rural not including townships	54	0.02	0.02	0.02
Ada	**All unpaved emissions**	**142**	0.50	0.39	0.44
Canyon	**All unpaved Emissions**	**316**	1.13	0.87	0.98
Ada & Canyon	**All unpaved Emissions**	**458**	2.91	2.25	2.53

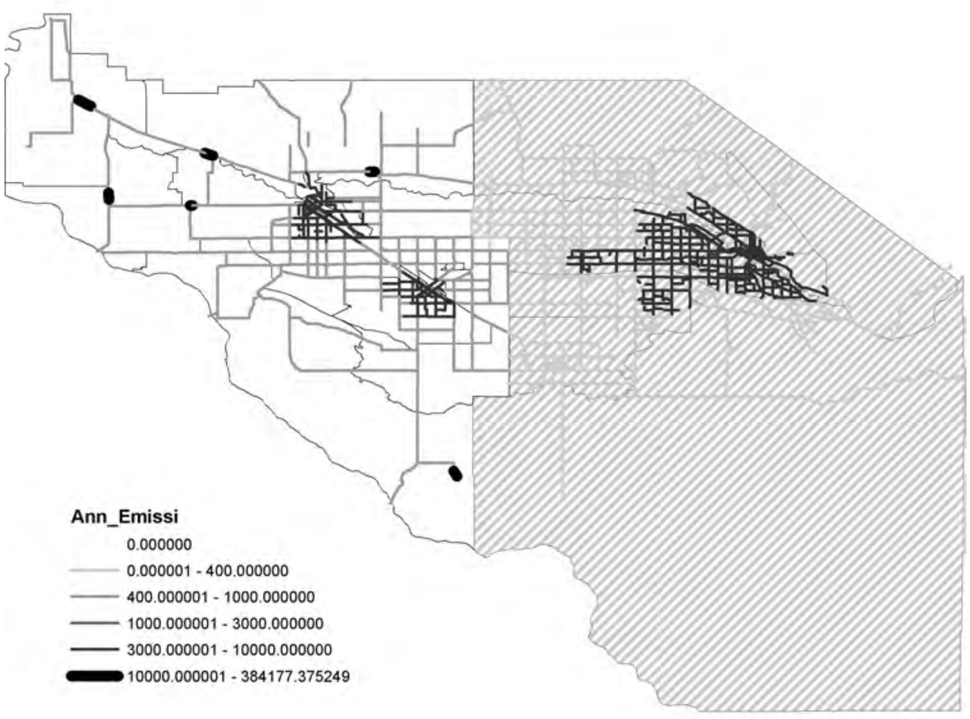


Figure 5-5. Map of distributions of unpaved road dust emissions. Emissions per link have been normalized with the length of the link. The units of the numbers in the legend are grams per day per km of link. Darker lines correspond to links with higher emissions on a per kilometer basis. The thick black spots in Canyon County correspond to the rural townships.

5.3.3 Comparisons of Road dust emissions with prior work and silt loading

Table 5-15 shows an inter-comparison of paved road dust emissions estimation methods. In addition to the TRAKER method, four silt loading methods also appear in the table, two from the current study, and two that are based on previous work performed by SAI (1997). The emissions estimates using silt loading from the current study are labeled TVRDS SL1 and TVRDS SL2. In calculating TVRDS SL1 emissions, the silt loadings reported in Table 3-7 are used for arterial, collector, and local roads. Since road vacuuming was not performed on freeways, no on-site silt loading data were available for interstates. The EPA AP-42 suggested default value of 0.02 g/m^2 was used for interstates. Equation 3-3 was used to calculate the emissions factors for the different road types based on the silt loading values. Actual emissions were calculated by applying VMT data from the year 2000 Traffic Demand Model results. The TVRDS SL2 method differs from the TVRDS SL1 method only in the value used for silt loadings on freeways. In TVRDS SL2, freeway silt loadings are assumed to be the same as for arterials, 1.9 g/m^2 for winter conditions and 0.5 g/m^2 for the remainder of the year (non-winter). The use of these silt loadings in place of the default AP-42 values is probably more realistic since based on TRAKER measurements, it was observed that emissions factors from freeways were similar to those from arterial roads (see Table 5-5, bottom four entries).

SAI (1997) prepared an emissions inventory for paved and unpaved roads using the silt loading method. The results of that inventory appear in Table 5-15. Since the inventory was assembled in 1997, year 2000 traffic information was not available and SAI had to project future VMT. The entry in Table 5-15 entitled "SAI 2000 Equivalent" uses the same silt loading values that SAI used in the original emissions inventory. However, actual year 2000 Traffic Demand Model results were used to estimate vkt.

Table 5-15. Inter-comparison of emissions inventory methods for average winter day and average annual paved road dust emissions for the year 2000 in the Treasure Valley.

Inventory Method	Average Winter Day Paved Road Emissions (metric tons/day)	Average Day emissions on annual basis (metric tons/day)
TVRDS TRAKER	81.2	62.0
TVRDS SL1 (Interstates SL=0.02 g/m^2)	58.1	31.3
TVRDS SL2 (Interstates Winter SL =1.9 g/m^2, Non-winter SL=0.5 g/m^2)	75.3	40.6
SAI (1995)	32.2	28.1
SAI 2000 Equivalent With Year 2000 TDM Data	35.4	31.2

TVRDS TRAKER = current study using TRAKER
TVRDS SL1 = current study using local silt data with assumption that interstate silt loading is equal to default EPA value of 0.02 g/m^2
TVRDS SL2 = current study using local silt data with assumption that interstate silt loading is same as for arterials with a value of 1.9 g/m^2 for winter and 0.5 g/m^2 for non-winter days
SAI (1995) = emissions reported in SAI emissions inventory
SAI-2000 Equivalent = Uses same silt loading assumptions as SAI inventory, but actual Traffic Demand Model network for the year 2000 instead of projection.

For average winter day, paved road dust emissions using the TRAKER method are 2.3 times those from the SAI 2000 Equivalent method (81.2 vs. 35.4 metric tons per day). The TRAKER method gives 1.4 times higher emissions compared to the AP-42 method using on-site silt loadings (TVRDS SL1). However, using the more realistic silt loadings for interstates (TVRDS SL2), the TRAKER-based emissions of 81.2 tons per day and the AP-42-based emissions of 76.3 tons per day only differ by 8%.

Taken on an average annual basis, TRAKER-based emissions result in approximately twice the the silt-based emissions using the TVRDS SL1, SAI, and SAI 2000 Equivalent methods. Compared to TVRDS SL2, TRAKER-based emissions are approximately 50% higher.

It is interesting to note that the SAI and SAI 2000 emissions inventories show a modest difference (~ 12%) between average winter day and average annual emissions. In contrast, TRAKER based measurements show that winter emissions are 31% higher than the annual average. The AP-42-based measurements using on-site silt loadings (TVRDS) both indicate that winter emissions are 85% higher than the annual average. SAI did not have on-site data available for assembling their emissions inventory; this may be the source of the differences between trends observed in that study and those observed in the Treasure Valley Road Dust Study.

A comparison of unpaved road emissions inventories using the TRAKER and those assembled by SAI (1997) is shown in Table 5-16. The emissions estimates from the two studies are very similar for both average winter day emissions and for daily emissions on an annual basis.

Table 5-16. Comparison of unpaved road dust emissions estimates between the TRAKER method used in the present study and the SAI emissions inventory (1997).

Emissions Inventory	Average Winter Day Unpaved Road Emissions (metric tons/day)	Average Day emissions on annual basis (metric tons/day)
TRAKER	2.3	2.5
SAI (1995)	2.4	2.8

6. MODIFICATIONS OF ROAD DUST EMISSIONS INVENTORIES FOR DISPERSION MODELS

The discrepancy between fugitive dust emissions inventories and the relative contribution of fugitive dust to ambient PM_{10} concentrations is well-documented (Watson and Chow, 2000; Countess, 2001). In particular, dispersion models that use fugitive dust emissions estimates as input generally overstate the fraction of dust in ambient PM_{10} samples. The principal reason for this discrepancy is that a significant amount of dust is removed from the atmosphere within a few hundred meters of the source. Since most regional scale air quality models employ grid resolutions on the order of 1 km or greater, much of the short range dust removal is "missed" by the models. Thus, there exists a physical disconnect between the near-field emissions measurements used to assemble inventories and the PM_{10} dust inputs used in the air quality models.

In this section, we employ a simple dispersion model that accounts for near-field deposition of particles with aerodynamic diameter less than 10 μm. The purpose of this exercise is to obtain an estimate of the fractional reduction in PM_{10} that is due to deposition of particles over the first several hundred meters after emission. This aspect of fugitive dust research has received much attention in recent years and efforts are underway to refine modeling techniques to account for this effect (e.g. the box model proposed by Gillette and described in Countess, 2001).

6.1 Methods

The one-dimensional, time-dependent atmospheric transport equation (e.g. Seinfeld, 1986) was solved numerically for both neutral and stable atmospheric conditions. Invoking the K-theory simplification, the full equation is:

$$\frac{\partial c}{\partial t} + u\frac{\partial c}{\partial x} = \frac{\partial}{\partial x}\left(K_{xx}\frac{\partial c}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_{yy}\frac{\partial c}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_{zz}\frac{\partial c}{\partial z}\right) + S_i - S_o \qquad (6\text{-}1)$$

where c is the concentration of the species of interest, u is the velocity in the x-direction, K_{ii} are the turbulent diffusivities in the x, y, and z directions, S_i and S_o are the sources and sinks. The one dimensional form of Eq. 6-1 is independent of the velocity u:

$$\frac{\partial c}{\partial t} = \frac{\partial}{\partial z}\left(K_{zz}\frac{\partial c}{\partial z}\right) + V_d\frac{\partial c}{\partial z} \qquad (6\text{-}2)$$

where V_d , the deposition velocity is the source/sink term.

The numerical grid consisted of 41 nodes ranging from z = 0 m to z = 250 m. There were 8 nodes within the first meter AGL, 19 nodes within 5 m AGL, 26 nodes within 25 m AGL, 33 nodes within 100 m AGL, and 8 nodes between 100 and 250 m AGL. Figure 6-1 shows a schematic of the numerical grid.

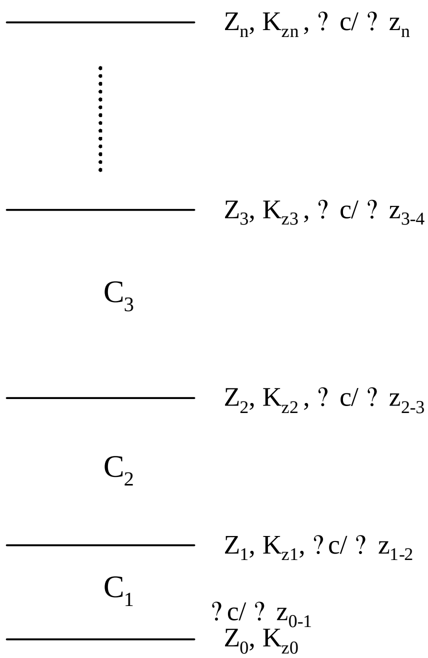


Figure 6-1. Schematic of one-dimensional numerical grid. Concentrations are evaluated between nodes while the remaining parameters are evaluated at the nodes.

Euler's approach was used to step Eq. 7-2 forward in time. For example, at time t+1, the concentration in the second grid cell, $C_{2,t+1}$ was calculated as:

$$C_{2,t?1} ? C_{2,t} ? \frac{?K_{z2} ? ??C_{1?2,t} / ?z_{2?3}?_t ? K_{z1} ? ??C_{2?3,t} / ?z_{1?2}?_t ? V_d ??C_{2?3,t} ??}{z_2 ? z_1} ? ?t$$

where

$$?C_{1?2} / ?z_{1?2} ? \frac{C_2 ? C_1}{?\frac{z_2 ? z_0}{2}?} \text{ and } ?C_{2?3} / ?z_{2?3} ? \frac{C_3 ? C_2}{?\frac{z_3 ? z_1}{2}?} .$$

are approximations to the derivative, $?c/?z$.

The turbulent dispersion parameter K_{zz} was determined based on the atmospheric stability. For neutral conditions (Seinfeld, 1986 after Myrup and Panzieri, 1976),

$$K_{zz} ? \begin{cases} ?u^* z ? & z/z_i ? 0.1 \\ ?u^* z ?1.1 ? z/z_i ?? & 0.1 ? z/z_i ? 1.1 \\ 0 ? & z/z_i ? 1.1 \end{cases} \qquad (6\text{-}3)$$

where ? is the von Karman constant and is equal to 0.4, z_i is the mixed layer height assumed to be 200 m for wintertime conditions, and u^* is the friction velocity, which can be calculated by the boundary layer equation

$$\frac{u(z_{ref})}{u^*} ? \frac{1}{?} \ln \frac{z_{ref}}{z_0^*} \tag{6-4}$$

where $u(z_{ref})$ is the wind speed at height z_{ref}, and z_0^* is the roughness length for the surface. For the purposes of illustration, the wind speed was assumed to be 1 m/s at a height of 10 m, and z_0^* was assumed to be 0.01 m. This roughness height corresponds approximately to a surface that is covered with lawn (Seinfeld, 1986; after McRae et al., 1982). Use of Eq (6-4) gives a value of 0.058 m/s for u^*.

For stable atmospheric conditions,

$$K_{zz} ? \frac{? u^* z}{0.74 ? 4.7(z/L)} f(z,u^*) \tag{6-5}$$

where L is the Monin-Obukhov length scale and f is a correction term for the coriolis force. L was assumed to be 10 m indicating stable to very stable conditions. The coriolis correction, f, was assumed to be equal to unity since the modeling domain only extends to the modest height of 250 m AGL.

The total deposition velocity V_d was assumed to be equal to the sum of two components,

$$V_d ? V_s ? V_i \tag{6-6}$$

where V_s is the stokes settling velocity and V_i is the removal rate of particles due to impaction on surfaces. The Stokes settling velocity is given by

$$V_s ? \frac{1}{18} \frac{D_p^2 ?_p g}{?} \tag{6-7}$$

Where D_p is the diameter of the particle in m, $?_p$ is the density of the particle (1000 kg/m^3), g is the gravitational constant (9.81 m/s^2), and ? is the viscosity of air (1.7?10^{-5} Kg?m/s at 20 ?C).

The impaction deposition velocity, V_i was estimated from experimental curves (Seinfeld, 1986; after McMahan and Denison, 1979). The impaction velocity was only applied to the first 20 cm AGL of the modeling domain since in the absence of surfaces, impaction does not occur. The values used in the model are shown inTable 6-1. At heights above 20 cm, the deposition velocity was simply equal to the Stokes settling velocity, V_s. Note that deposition, either by impaction or by gravitational settling is negligible for particles with diameters less than 1.4?m and that the model was not run for those small particle sizes.

Table 6-1. Aerodynamic particle sizes simulated and corresponding removal rates due to impaction

Aerodynamic Diameter (? m)	Removal rate due to impaction, V_i (m/s)
9.78	0.1
7.21	0.1
5.59	0.08
3.95	0.07
2.88	0.02
2.04	0.02
1.44 and less	0

For the initial condition (t=0), the concentration of particles was assumed to be uniform over the first 2 m AGL and zero for the remainder of the domain. The top boundary condition was that dc/dz was zero at z=240 m. The initial conditions were marched forward in time to t= 500 seconds in increments of 50 ms for the first 2.5 seconds, followed by 100 ms for the next 17 seconds, followed by 200 ms thereafter. This slow ramping of the time steps allows for minimization of numerical errors when spatial gradients are large due to the initial conditions.

6.2 Results

The results of the numerical simulation are shown for all the particle sizes examined in Table 6-2 and Table 6-3 under neutral and stable conditions, respectively. The tables report the fraction of a particle size that remains suspended after the initial emissions at t=15, 30, 60, 120, 240, and 500 seconds. The tables show that under both neutral and stable conditions, very little removal by deposition occurs for 1.44 ?m particles within the time frame examined. In contrast, for the largest particles examined under neutral conditions (9.87 ?m) only 72% of the original emission remains in suspension after 30 seconds and only 36% remains after 500 s. Figure 6-2 shows a time series of 7.21 ?m particles remaining in suspension. The figure shows that the particles are removed quickly within the first 200 seconds and then continue to fall out at a lesser rate. The particle removal rates are approximately the same for both neutral and stable conditions during the first 30 seconds. Thereafter, the curves for the two atmospheric conditions deviate from one another and removal rates are noticeably higher under stable conditions. Figure 6-3 shows the time series progression of the vertical profiles of concentration for 7.21 ?m particles. Under neutral conditions, particles disperse vertically more quickly than under stable conditions. Effectively, this makes particles less available for removal by deposition near the ground under neutral conditions than under stable conditions.

The fraction of particles remaining in suspension shown in Table 6-2 and Table 6-3 can be applied to the entire size distribution of particles emitted by a particular source. The size distribution of road dust for the TVRDS at the point of emissions was discussed earlier in section 4.1. That size distribution has been used to estimate the fraction of PM_{10} mass (mass concentration of all particles with aerodynamic diameter less than 10?m) that remains suspended and the results are shown in Figure 6-4. According to the model results, under neutral conditions, PM_{10} is depleted by approximately 25% just 30 seconds downwind of the point of emissions and approximately 55% 500 seconds downwind. PM_{10} depletion is slightly more pronounced under stable conditions.

Table 6-2. Fraction of particles remaining under neutral atmospheric conditions

Dp (? m)	15 s	30 s	60 s	120 s	250 s	500 s
1.44	100%	100%	100%	100%	99%	99%
2.04	90%	84%	76%	68%	61%	54%
2.88	90%	84%	76%	68%	60%	53%
3.95	83%	76%	67%	59%	51%	44%
5.59	82%	75%	66%	57%	49%	42%
7.21	82%	74%	65%	56%	48%	40%
9.87	80%	72%	62%	52%	43%	36%

Table 6-3. Fraction of particles remaining under stable atmospheric conditions

Dp (? m)	15 s	30 s	60 s	120 s	250 s	500 s
1.44	100%	100%	100%	100%	99%	99%
2.04	90%	84%	76%	66%	55%	45%
2.88	90%	84%	76%	66%	55%	45%
3.95	83%	76%	67%	56%	46%	36%
5.59	82%	75%	66%	55%	44%	34%
7.21	81%	74%	64%	52%	41%	31%
9.87	81%	72%	61%	49%	37%	26%

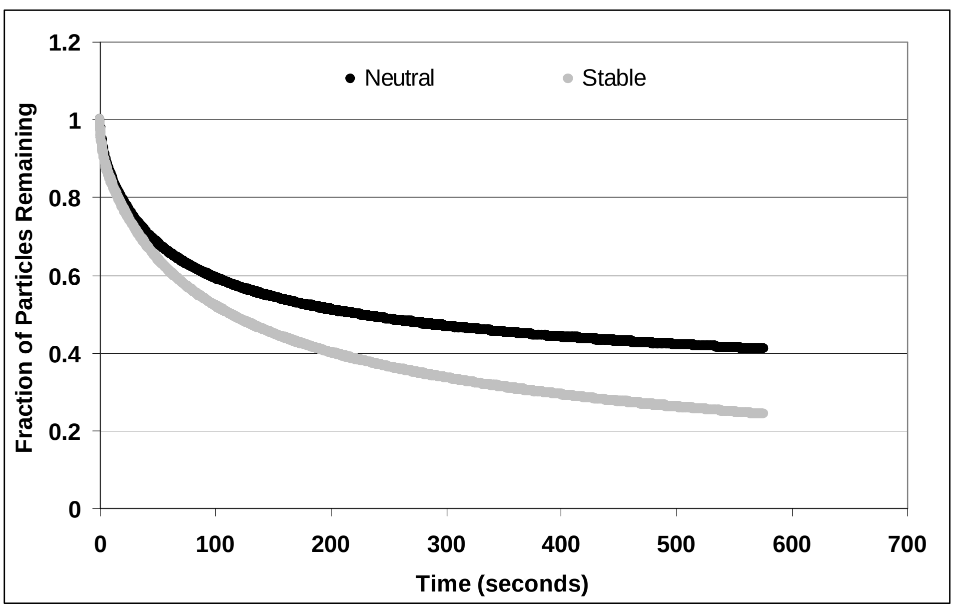


Figure 6-2. Fraction of 7.21 ? m particles that remain in suspension vs. time from emission

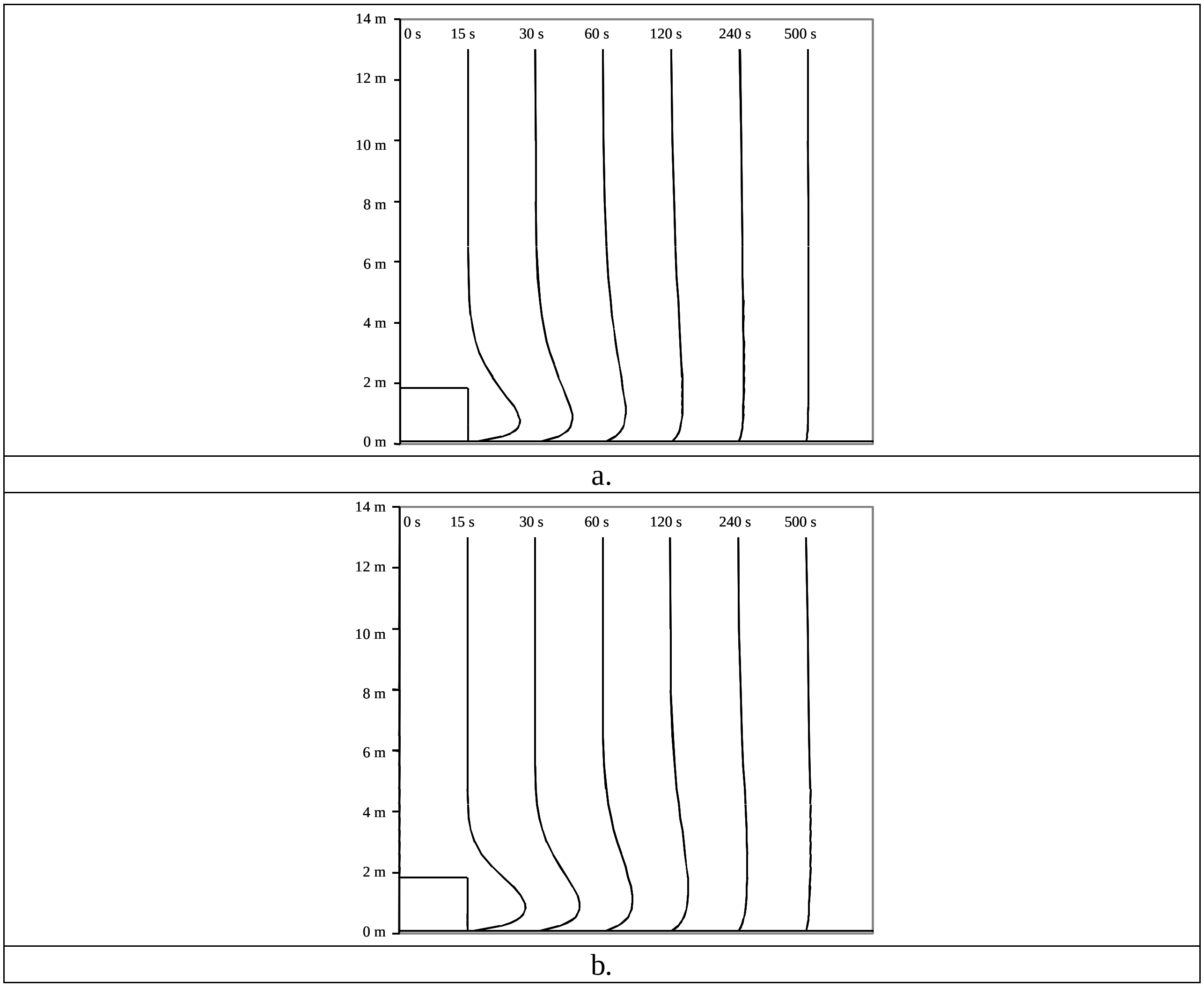


Figure 6-3. Time series of concentration with height for a. neutral conditions and b. stable conditions.

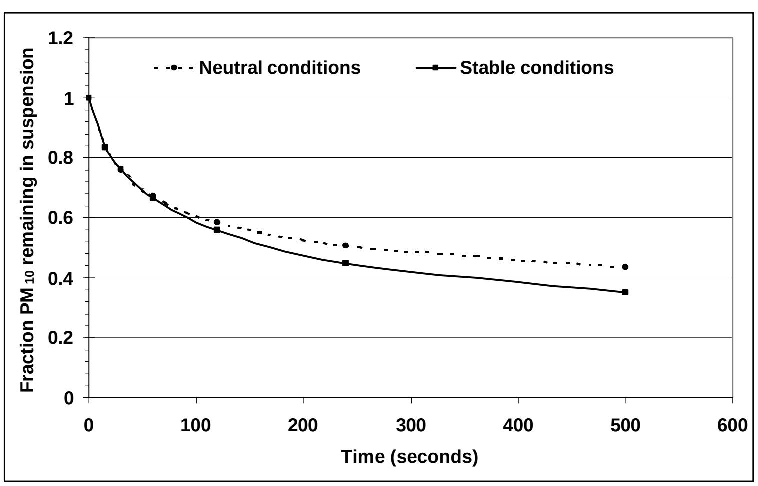


Figure 6-4. Fraction of PM_{10} remaining in suspension vs. time after emission. The size distribution at the point of emission is given in section 4.1.

6.3 Discussion

The depletion of PM_{10} in the proximity of the emissions source has important implications for the use of road dust emissions in air quality models. PM_{10} dust emissions used to estimate emissions factors are measured within 5 to 50 m of a road. Emissions calculated based on those factors do not account for the depletion of PM_{10} as the plume travels further downwind. Many of the frequently used urban and regional scale air quality models assume that ground level emissions are initially uniformly mixed over a certain height, typically the distance from the ground to the first node in the numerical grid (20– 40 m). This assumption does not adequately allow for the removal by deposition of the larger particles in the PM_{10} size range. Consequently, air quality models that use road dust emissions as input without accommodation for near-source removal of particles will likely overestimate the ambient concentrations of road dust PM_{10}.

Table 6-4 shows how changes in the parameters used in the model can affect the fraction of PM_{10} that remains suspended after 60 seconds. The model is sensitive to some of the parameter values and fairly insensitive to others. For example, varying the roughness length under neutral conditions over several orders of magnitude has only a modest effect on the fraction of particles remaining in suspension. On the other hand, the value used for deposition rate due to impaction can have substantial consequences. If impaction is not accounted for at all (V_i = 0) and particles were only allowed to deposit by gravitational settling, then the fraction that remains in suspension is 95%, considerably higher than the 65% achieved with the model assumptions here. Another important parameter is the assumption for the initial distribution of particles in the vertical direction. A factor of two increase or decrease in the initial pulse height can vary the fraction remaining between 45% and 80%.

Table 6-4. The effects of perturbation of model inputs on fraction of particles remaining in suspension at t = 60 seconds.

Parameter	Stability	Baseline value	Baseline fraction remaining	Perturbed value	Fraction remaining
z_0, u^*	Neutral	0.01 m, 0.058 m/s	65%	1 m, 0.17 m/s	60%
z_0, u^*	Neutral	0.01 m, 0.058 m/s	65%	0.1 m, 0.087 m/s	62%
z_0, u^*	Neutral	0.01 m, 0.058 m/s	65%	0.001 m, 0.043 m/s	67%
V_i	Neutral	0.08 m/s	65%	0.16 m/s	63%
V_i	Neutral	0.08 m/s	65%	0.04 m/s	68%
V_i	Neutral	0.08 m/s	65%	0 m/s	95%
L	Stable	10 m	64%	1 m	70%
L	Stable	10 m	64%	1000 m	64%
Initial distribution	Neutral	0-2 m	65%	0-4 m	80%
Initial distribution	Neutral	0-2 m	65%	0-1 m	46%
Z_i	Neutral	200 m	65%	400 m	65%
Z_i	Neutral	200 m	65%	100 m	65%

The model presented here is useful for demonstration of the behavior of road dust emissions near the point of origin. However, several simplifying assumptions have been made in the formulation of this model and many of the parameters only represent approximations. In future work, and in keeping with the suggestions of both Watson and Chow (2000) and Countess (2001), it is important to better estimate the conditions under which emissions from roads are transported. Most notably, better field measurements of the impaction term V_i and the initial plume distribution should be obtained under neutral and stable atmospheric conditions.

Furthermore, the vertical profile of the dust plume downwind of the source should be measured and documented to allow for comparison with model estimates such as those shown inFigure 6-3.

7. SOURCE MEASUREMENTS

Source apportionment requires information about the chemical and physical characteristics of the emissions that are likely to affect pollutant concentrations at a receptor. For the Chemical Mass Balance (CMB) receptor model (Watson et al., 1994), the required information is the fractional composition of each chemical species in the source emissions and an estimate of the variability of those compositions. This section describes the source profiles that were measured in the Treasure Valley Road Dust Study.

7.1 Source Types and Characterization Methods

The potential source types that contribute to PM_{10} in the Treasure Valley study region are: 1) fugitive dust from paved and unpaved roads, road salt applied to paved roads during winter, construction, and sand and gravel operations (all termed “geological material”); 2) motor vehicle exhaust from passenger cars, buses, and trucks; 3) soot from residential wood combustion; 4) secondary aerosols (i.e., ammonium nitrate and ammonium sulfate partides that form from gaseous ammonia, oxides of nitrogen, and sulfur dioxide emissions); 5) boiler emissions from heavy oil or coal combustion for power and heat generation; and 6) other miscellaneous industrial source emissions.

There are many source sub-types within some of these categories that cannot be distinguished by commonly measured chemical species. The source contribution from each category is a composite of these different sub-types, and the derived profile must represent this mixture. For example, with currently measured chemical species, it is not possible to distinguish contributions from resuspended unpaved road dust, windblown dust, and construction dust from each other. These sources are therefore grouped together into a source type known as geological material.

A number of methods have evolved over the past decade to extract samples from sources that have chemical and physical properties similar to those found at a receptor. Several of these methods are described in detail by Gordon et al. (1981), Chow et al. (1986), and Houck (1991), and the methods selected for this study were described by Chow et al. (1994a). In each of these methods, emitted particles are collected on filters through size-selective inlets and chemically analyzed for a variety of chemical species.

For the TVRDS, 16 road soil samples were collected at several locations in the Treasure Valley using the following methods:

?? Sweeping or scooping a surface layer of soil, paved road dust, and unpaved road dust using an electric vacuum or broom. Broom samples were collected in plastic Ziploc bags. Vacuum samples were collected in the vacuum bag which were sealed with packing tape and placed in Ziploc bags.

?? Sieving each sample to obtain a suspendable fraction (< 38 µm geometric diameter), injecting this fraction into an enclosed chamber, and sampling onto Teflon-membrane and quartz-fiber filters through PM_{10} and $PM_{2.5}$ impactor inlets (Chow et al., 1994a).

In the laboratory, the soil samples were air-dried in a low-relative-humidity (approximately 20% to 30%) environment and sieved through a Tyler 400-mesh screen (< 38 ?m geometric diameter) prior to resuspension in the laboratory chamber following the procedures described by Chow et al. (1994a).

Filter samples were drawn through PM_{10} and $PM_{2.5}$ inlets. Most of the mass of geological material is in the coarse particle portion of PM_{10} (Houck et al., 1989a), and similar compositions were found for the $PM_{2.5}$ and PM_{10} geological profiles (Chow and Watson, 1994b).

Two additional samples were collected during the winter sampling period on board the TRAKER vehicle. Particles suspended from the road surface behind a moving tire were sampled through a tube into a plenum. A portion of the sample stream was drawn through a filter pack preceded by impactors with aerodynamic size cuts of either 10 ?m or 2.5 ?m. These filters were analyzed directly for mass and chemical speciation.

All source profile samples were weighed and chemically characterized at the Desert Research Institutes Environmental Analysis Facility in Reno, Nevada. Samples were analyzed using Ion Chromatography (IC) for major ions, Automated Colorimetry (AC) for ammonium, X Ray Fluorescence (XRF) for elements, and Thermal Optical Reflectance (TOR) for organic and elemental carbon. Table 7-1 lists all the chemical species analyzed and their corresponding mnemonics.

Coarse particle Al, Si, P, Cl, K, and Ca values determined by XRF were originally adjusted for large particle self-absorption using the theoretical formulation developed by Dzubay (1975). This adjustment is a function of particle size distribution and composition. Since the actual particle size distribution and composition is unknown, the uncertainty of these adjustments is up to ± 25%, and is reflected in the reported uncertainty. Particle size effects for Na and Mg are so large and variable that we cannot make accurate corrections for these two elements. Their raw, uncorrected concentrations are included in the data files, but they should not be considered quantitative for fine or coarse samples.

A standard quality assurance test for speciated aerosol samples is to compare the reconstructed mass to the measured mass. Reconstructed mass should be less than or equal to the measured gravimetric mass within the limits of analytical uncertainties. Typical ratios of reconstructed mass to measured mass for PM10 range from 75% to 95%. Reconstructed mass is calculated from major species mass concentrations using the following equations to account for the unmeasured components of the aerosol (i.e., oxygen associated with mineral oxides and hydrogen associated with organic carbon compounds):

[Soil] = 2.2*[Al] + 2.49*[Si] + 1.63*[Ca] + 2.42*[Fe] + 1.94*[Ti]

[Organic Carbonacious Material (OCM)] = 1.4*[OC]

[Elemental Carbon (EC)] = [EC]

[Ammonium Sulfate] = 1.375*[SO_4^{2-}]

[Ammonium Nitrate] = 1.29*[NO_3^-]

Comparison of the major aerosol components with the total mass indicates that the contribution of geologic material was over-represented in the source profiles. The average and standard deviation of the ratio of reconstructed mass to measured mass are 1.12 +/- 0.08 for PM_{10} and 0.91 +/- 0.09 for $PM_{2.5}$. For many of the speciated PM_{10} source profiles, the soil component of the aerosol was larger than the measured mass of the PM_{10}. These results suggest that the Dzubay correction described above over compensates for the large particle self absorption. When the correction factor is not applied to the elemental concentrations, the ratio or reconstructed mass to measured mass is 0.75 +/- 0.07 for PM_{10} and unchanged for $PM_{2.5}$.

Because the sum of aerosol component mass is greater than the measured aerosol mass when the Dzubay correction factor is applied, the decision was made to calculate the final source profiles described below without applying the Dzubay correction factor for large particle self absorption. In order to account for the uncertainties of this phenomenon, the precisions of each chemical abundance are the precisions of the Dzubay corrected abundances.

The individual source samples are identified in Table 7-2. The locations at which they were collected are described in the earlier Silt Loading section. Table 7-2 also assigns mnemonic codes to identify the profiles as they appear in the CMB source contribution reports. Not all of the species that contribute to PM10 were measured, and the abundances do not sum to 100%.

Not all of these profiles were used in the CMB calculations, but all profiles were made available for initial model sensitivity tests and final source apportionment. Profiles used for source apportionment are often composites derived from several individual sample profiles. For this study, the individual geological profiles were composited based on the following characteristics: season collected (i.e. winter or summer), sample type (paved road, unpaved road, sand used for road traction, chips used for chip-sealing, TRAKER samples), and particle size (i.e. PM10, PM2.5, and Coarse).

7.2 Geological Source Profiles

Sampling locations for each of the geological source samples are given in Table 7-2. These included paved-road vacuum samples, road sanding material, and unpaved road swept samples. The top 0.5 or 1 cm of surface material was swept from unpaved surfaces, since this represents the reservoir available for suspension by wind or vehicle movement. Paved road dust was collected by vacuuming surface material samples from several different sections of each surface. Chapter 2 discusses sample collection in greater detail.

Table 7-1. Source Profile Key

Mneumonic	Description
MSGC	Mass
CLIC	Chloride
N3IC	Nitrate
S4IC	Sulfate
N4CC	Ammonium
NAAC	Soluble Sodium
KPAC	Soluble Potassium
OCTC	Organic Carbon
ECTC	Elemental Carbon
TCTC	Total Carbon
NAXC	Sodium
MGXC	Magnesium
ALXC	Aluminum
SIXC	Silicon
PHXC	Phosphorous
SUXC	Sulfur
CLXC	Chlorine
KPXC	Potassium
CAXC	Calcium
TIXC	Titanium
VAXC	Vanadium
CRXC	Chromium
MNXC	Manganese
FEXC	Iron
COXC	Cobalt
NIXC	Nickel
CUXC	Copper
ZNXC	Zinc
GAXC	Gallium
ASXC	Arsenic
SEXC	Selenium
BRXC	Bromine
RBXC	Rubidium
SRXC	Strontium
YTXC	Yttrium
ZRXC	Zirconium
MOXC	Molybdenum
PDXC	Palladium
AGXC	Silver
CDXC	Cadmium
INXC	Indium
SNXC	Tin
SBXC	Antimony
BAXC	Barium
LAXC	Lanthanum
AUXC	Gold
HGXC	Mercury
TLXC	Thallium
PBXC	Lead
URXC	Uranium

Table 7-2. Table of geologic samples collected for resuspension and chemical analysis in the Treasure Valley Road Dust Study. The Mnemonic indicates how the samples were composited to from individual source profiles.

Season	Site	Field Sample ID	Sample Date	Sample Type	Lab ID	Resuspension and Chemical Analysis	County	Source Profile Mnemonic
Winter	Riva Ridge North of Reutzel Dr.	BOISL001 BOISL002 BOISL003	3/1/2001	paved	RS562	Y	Ada	TVRDWIPV
Summer	Riva Ridge North of Reutzel Dr.	BOISL028 BOISL029 BOISL030	7/12/2001	paved	RS622	Y	Ada	TVRDSUPV
Winter	Apple St. Between Wright and LaFayette	BOISL004 BOISL005 BOISL006	3/3/2001	paved	RS565	N	Ada	
Summer	Apple St. Between Wright and LaFayette	BOISL053 BOISL054 BOISL055	7/13/2001	paved	RS623	N	Ada	
Winter	13th St. North of Hays	BOISL007 BOISL008 BOISL009	3/4/2001	paved	RS568	Y	Ada	TVRDWIPV
Summer	13th St. North of Hays	BOISL045 BOISL046 BOISL047	7/13/2001	paved	RS624	Y	Ada	TVRDSUPV
Winter	Front St. Between 3rd and 5th	BOISL010 BOISL011 BOISL012	3/4/2001	paved	RS571	Y	Ada	TVRDWIPV
Summer	Front St. Between 3rd and 5th	BOISL061 BOISL062 BOISL063	7/14/2001	paved	Rs625	Y	Ada	TVRDSUPV
Winter	West Park Dr. West of Milwaukee	BOISL013 BOISL014 BOISL015	3/6/2001	paved	RS574	Y	Ada	TVRDWIPV
Summer	West Park Dr. West of Milwaukee	BOISL050 BOISL051 BOISL052	7/14/2001	paved	RS626	N	Ada	
Winter	Maple Grove North of Tillamook	BOISL016 BOISL017 BOISL018	3/6/2001	paved	RS577	N	Ada	
Summer	Maple Grove North of Tillamook	BOISL031 BOISL032 BOISL033	7/12/2001	paved	RS627	N	Ada	
Winter	Garrity Blvd. Between Cavalry and 11th	BOISL019 BOISL020 BOISL021	3/7/2001	paved	RS580	Y	Canyon	TVRDWIPV
Summer	Garrity Blvd. Between Cavalry and 11th	BOISL067 BOISL068 BOISL069	7/17/2001	paved	RS628	Y	Canyon	TVRDSUPV
Winter	Amity Between Colorado and Diamond	BOISL022 BOISL023 BOISL024	3/7/2001	paved	RS583	N	Canyon	
Summer	Amity Between Colorado and Diamond	BOISL064 BOISL065 BOISL066	7/17/2001	paved	RS629	Y	Canyon	TVRDSUPV

Table 6-1 (continued). Table of geologic samples collected for resuspension and chemical analysis in the Treasure Valley Road Dust Study. The Mnemonic indicates how the samples were composited to from individual source profiles.

Season	Site	Field Sample ID	Sample Date	Sample Type	Lab ID	Resuspension and Chemical Analysis		County	Source Profile Mnemonic
Winter	6th St. Between 6th Avenue and 7th Ave	BOISL025 BOISL026 BOISL027	3/7/2001	paved		RS586	N	Canyon	
Summer	6th St. Between 6th Avenue and 7th Ave	BOISL070 BOISL071 BOISL072	7/17/2001	chip material		RS630	Y	Canyon	TVRDSUCH
Winter	Howry	BOISL034 BOISL035 BOISL036	3/6/2001	unpaved		RS589	N	Ada	
Winter	Cloverdale Farm Road	BOISL037 BOISL038 BOISL039	3/17/2001	unpaved		RS592	Y	Ada	TVRDWIUP
Summer	Cloverdale Farm Road	BOISL076 BOISL077 BOISL078	7/26/2001	unpaved		RS632	Y	Ada	TVRDSUUP
Winter	Pierce Park	BOISL040 BOISL041 BOISL042	3/16/2001	unpaved		RS595	Y	Ada	TVRDWIUP
Summer	Pierce Park	BOISL073 BOISL074 BOISL075	7/25/2001	unpaved		RS631	Y	Ada	TVRDSUUP
Winter	Unpaved Driveway Off Happy Valley	BOISL057 BOISL058 BOISL059	3/7/2001	unpaved		RS599	N	Canyon	
Summer	Access Road Near Lucky Peak Dam	BOISL079 BOISL080 BOISL081	7/25/2001	unpaved		RS633	N	Ada	
Winter	ACHD TC Sand	BOISL044	3/15/2001	De-icing grab sample		RS598	Y	Ada	TVRDWISA
Winter	Various Roads in Ada and Canyon County	BRDFTQ001 BRDFTQ002 BRDTTQ001 BRDTTQ002 BRDFQ001 BRDFQ002 BRDTQ001 BRDTQ002	3/16/2001	TRAKER Air background subtracted		NA	Y	Ada and Canyon	TVRDWITR

Figure 7-1 and Figure 7-2 show the chemical abundances of the seven geological source profiles. In each of the illustrations, the heights of the bars indicate the average fractional abundances for the indicated chemical, while the dot shows the root mean square precision of the composite profiles. When the height of the bar exceeds the position of the dot, and when the height of the bar is much higher than it is in other profiles, the corresponding species is considered as a good marker for that source type. Detailed source profile tables are shown in Section 7.4.

In each of these profiles, aluminum (Al), silicon (Si), potassium (K), calcium (Ca), iron (Fe), and organic carbon (OC) have large abundances with low variabilities. The abundance of total potassium (K) is five to ten times the abundance of soluble potassium (K+). PM_{10} calcium abundances are consistently within the range of 1% to 3% for all profiles. Calcium in geological material may be enriched naturally by calcium carbonate or calcium aluminosilicates or by erosion of concrete. PM_{10} silicon abundances account for the largest elemental contribution to the total mass (14% to 19%). Road dust is not a major source of soluble ions such as nitrate and sulfate which account only for 0.1% to 0.5% of the source profile by mass.

Substantial differences were found between paved and unpaved road PM_{10} source profiles from samples collected in both summer and winter. Paved road source profiles are composed of 12% to 16% organic carbon and 1.2% and 2.3% elemental carbon. Unpaved road samples are composed of only 2.5% to 4.5% organic carbon and less than 0.1% elemental carbon. Unpaved road dust samples are primarily composed of the geologic material used to make or maintain the road. The paved road samples contain eroded concrete and asphalt, tire and brake surface fragments, oil drips, and deposited exhaust particles. The enhanced organic and elemental composition observed in paved road dust is most probably due to a combination of tire and exhaust particles.

No significant differences were observed between the profiles based on season in which they were collected. The road sand profile has enriched levels of soluble sodium, chloride, and sulfate by a factor of 10 to 100 when compared to the winter paved road profile. These differences may be due to different geologic sources for the sanding material and paved road dust.

The summer chip sealing material collected in Canyon County was quite similar to the summer paved road dust profile with the exception of organic and elemental carbon. The chip sealing material is composed of 5 to 10 times less carbonaceous material than the paved road dust. In this respect, the chip sealing material profile was more similar to the summertime unpaved road profile, though we note that chip sealing material had approximately 7 times less chloride than the unpaved road samples.

Previous source apportionment studies (e.g., Chow et al., 1992a, 1992b; Watson et al., 1994) show that the chemical abundances and variabilities of the commonly measured elements, ions, and carbon in geological source profiles are sufficient to separate geological source contributions from other source types. More recent studies have shown that road salting material can be distinguished from paved road dust (Watson et al., 2000). The set of source profiles described here indicate that there are chemical differences associated with the profiles of paved road dust, unpaved road dust, and road sanding material. Application of sensitivity tests during the CMB modeling will indicate whether these differences are sufficient to resolve source contributions between these sources.

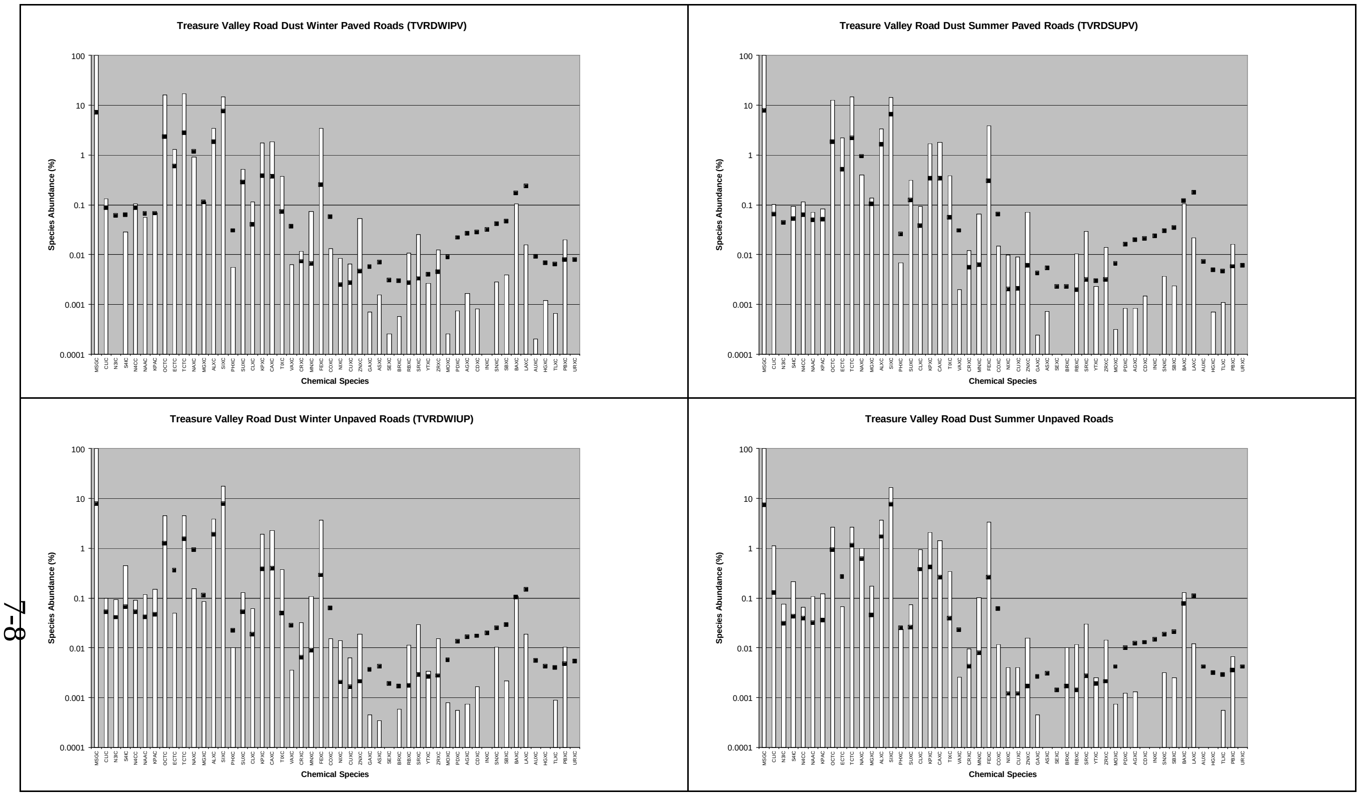


Figure 7-1. PM$_{10}$ source profiles of paved and unpaved road dust samples collected in the Treasure Valley in Winter and Summer 2001.

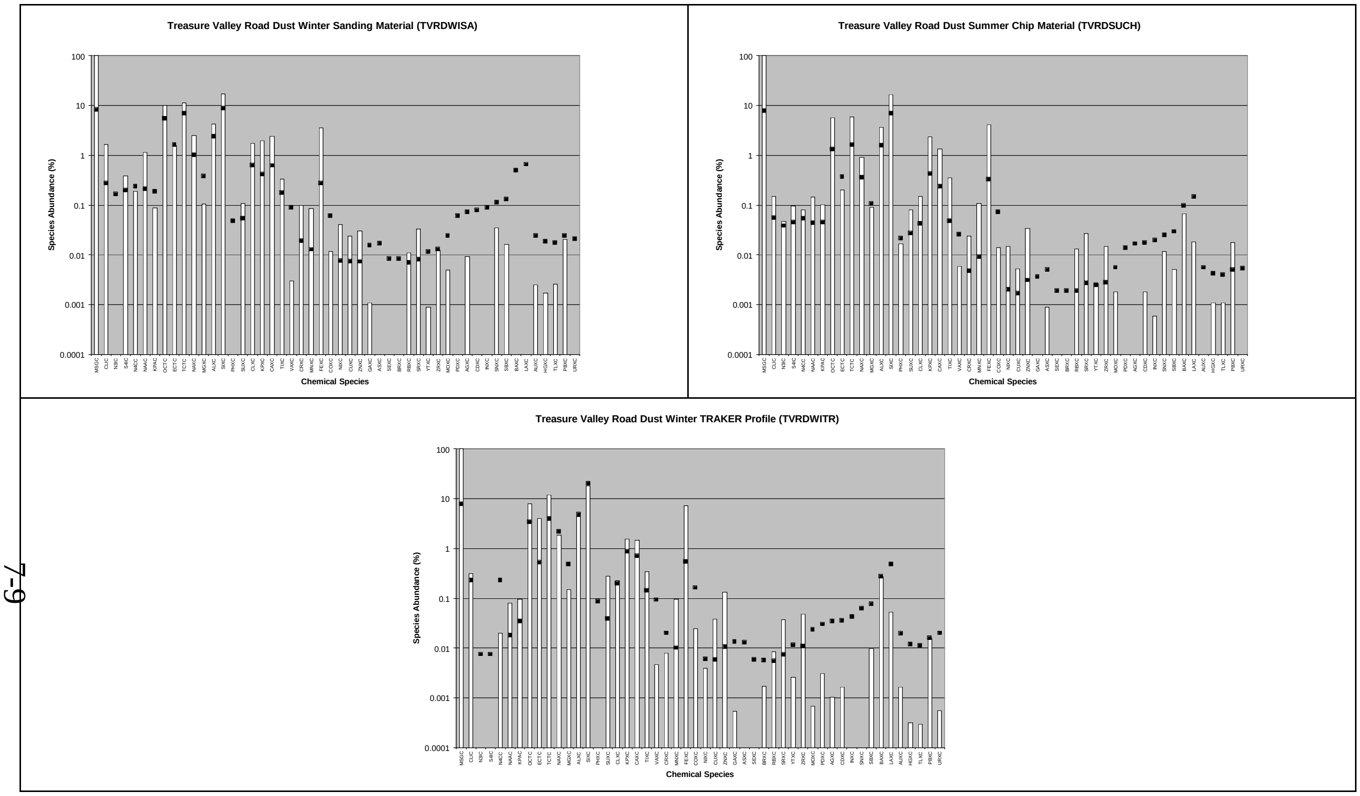


Figure 7-2. PM$_{10}$ source profiles of road sanding material, chip material used for chip-sealing road resurfacing, and particles collected on filters using the TRAKER system. All samples were collected in the Treasure Valley in Winter and Summer 2001.

7.3 Source Profile Summary

This *a priori* examination of source profiles for the study cannot determine which profiles will be distinguishable by CMB modeling. Current modeling software contains diagnostic tests to allow the degree of "co-linearity" (or similarity among profiles) to be evaluated for each combination of source and receptor data.

7.4 Detailed Source Profiles

Table 7-3 through Table 7-6 detail the source profiles for samples collected as part of the TVRDS.

Table 7-3. Source profiles of Winter Paved and Unpaved Road Dust collected in the Treasure Valley, 2001.

Profile Mnemonic	TVRDWIPV						TVRDWIUP					
Season	Winter						Winter					
Sample Type	Paved						Unpaved					
Size	10		2.5		C		10		2.5		C	
	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)
MSGC	100.0000	7.1243	100.0000	9.3326	100.0000	8.5678	100.0000	7.6891	100.0000	7.4830	100.0000	10.3474
CLIC	0.1350	0.0866	0.2978	0.3213	0.0943	0.0865	0.0975	0.0527	0.1860	0.1049	0.0624	0.0606
N3IC	0.0000	0.0599	0.0000	0.2261	0.0000	0.0593	0.0943	0.0407	0.0798	0.0736	0.1006	0.0486
S4IC	0.0289	0.0623	0.0000	0.2261	0.0338	0.0626	0.4487	0.0654	0.3732	0.1006	0.4795	0.0825
N4CC	0.1051	0.0860	0.3987	0.3221	0.0466	0.0856	0.0895	0.0523	0.1958	0.1045	0.0468	0.0601
NAAC	0.0557	0.0664	0.1023	0.2503	0.0447	0.0658	0.1195	0.0418	0.1590	0.0819	0.1032	0.0484
KPAC	0.0690	0.0672	0.1350	0.2515	0.0536	0.0667	0.1485	0.0466	0.2196	0.0862	0.1194	0.0552
OCTC	15.8744	2.3044	18.0099	8.3721	15.2637	2.3002	4.5162	1.2507	3.3630	2.6633	4.9765	1.3974
ECTC	1.2931	0.5942	1.9240	2.0340	1.1383	0.6126	0.0502	0.3547	0.0843	0.6550	0.0364	0.4221
TCTC	16.9864	2.7691	18.5756	10.0303	16.4585	2.7758	4.4470	1.5397	2.9619	3.2038	5.0398	1.7416
NAXC	0.9142	1.1852	1.2392	3.9094	0.8534	1.2250	0.1556	0.9095	1.2094	1.5035	-0.2827	1.1273
MGXC	0.1131	0.1124	0.3774	0.3572	0.0648	0.1181	0.0864	0.1132	0.2608	0.2166	0.0138	0.1344
ALXC	3.4068	1.8411	4.9497	0.4218	3.0299	2.2810	3.9050	1.8753	5.0790	0.3829	3.4414	2.6353
SIXC	14.5555	7.4601	19.0054	1.5635	13.5224	9.1773	17.3560	7.7151	21.8353	1.6077	15.6572	10.8478
PHXC	0.0056	0.0302	0.0089	0.0440	0.0048	0.0363	0.0101	0.0219	0.0181	0.0115	0.0069	0.0306
SUXC	0.5252	0.2814	0.7123	0.0853	0.4829	0.3277	0.1274	0.0519	0.1707	0.0189	0.1111	0.0718
CLXC	0.1156	0.0405	0.2035	0.0587	0.0951	0.0479	0.0616	0.0188	0.1142	0.0208	0.0422	0.0248
KPXC	1.7509	0.3764	1.9823	0.1691	1.6953	0.4632	1.9314	0.3828	2.0623	0.1538	1.8834	0.5367
CAXC	1.8271	0.3678	2.2106	0.2541	1.7387	0.4419	2.2999	0.3913	2.7350	0.2164	2.1419	0.5387
TIXC	0.3774	0.0719	0.3092	0.2746	0.3914	0.0721	0.3773	0.0489	0.3313	0.0845	0.3954	0.0600
VAXC	0.0062	0.0371	0.0019	0.1231	0.0072	0.0385	0.0036	0.0283	0.0000	0.0498	0.0050	0.0343
CRXC	0.0116	0.0073	0.0162	0.0240	0.0106	0.0074	0.0317	0.0064	0.0332	0.0125	0.0310	0.0075
MNXC	0.0726	0.0067	0.0854	0.0165	0.0695	0.0074	0.1065	0.0088	0.1216	0.0105	0.1003	0.0114
FEXC	3.4828	0.2494	4.1759	0.3401	3.3097	0.2942	3.6826	0.2875	4.2182	0.3131	3.4684	0.3737
COXC	0.0132	0.0574	0.0164	0.0675	0.0126	0.0698	0.0153	0.0628	0.0185	0.0657	0.0140	0.0839
NIXC	0.0084	0.0025	0.0134	0.0095	0.0073	0.0025	0.0138	0.0020	0.0209	0.0036	0.0109	0.0024
CUXC	0.0064	0.0027	0.0079	0.0108	0.0061	0.0026	0.0063	0.0017	0.0081	0.0033	0.0056	0.0019
ZNXC	0.0537	0.0046	0.0692	0.0116	0.0498	0.0051	0.0189	0.0021	0.0205	0.0036	0.0182	0.0026
GAXC	0.0007	0.0057	0.0036	0.0218	0.0003	0.0056	0.0005	0.0036	0.0000	0.0074	0.0006	0.0040
ASXC	0.0016	0.0069	0.0003	0.0240	0.0018	0.0072	0.0004	0.0042	0.0002	0.0081	0.0004	0.0050
SEXC	0.0003	0.0031	0.0001	0.0119	0.0003	0.0030	0.0001	0.0019	0.0001	0.0040	0.0001	0.0022
BRXC	0.0006	0.0030	0.0011	0.0117	0.0005	0.0029	0.0006	0.0017	0.0015	0.0037	0.0003	0.0020
RBXC	0.0108	0.0027	0.0134	0.0107	0.0103	0.0026	0.0113	0.0018	0.0125	0.0033	0.0109	0.0021
SRXC	0.0257	0.0033	0.0273	0.0110	0.0253	0.0035	0.0292	0.0029	0.0265	0.0041	0.0302	0.0037
YTXC	0.0027	0.0040	0.0012	0.0164	0.0030	0.0038	0.0034	0.0026	0.0020	0.0057	0.0039	0.0028
ZRXC	0.0126	0.0045	0.0177	0.0185	0.0113	0.0043	0.0152	0.0028	0.0185	0.0053	0.0139	0.0032
MOXC	0.0003	0.0089	0.0000	0.0338	0.0003	0.0087	0.0008	0.0057	0.0000	0.0117	0.0011	0.0065
PDXC	0.0007	0.0217	0.0096	0.0851	-0.0008	0.0211	0.0006	0.0134	0.0072	0.0281	-0.0021	0.0150
AGXC	0.0017	0.0265	0.0049	0.1035	0.0007	0.0257	0.0008	0.0163	0.0060	0.0341	-0.0013	0.0183
CDXC	0.0008	0.0279	0.0073	0.1090	-0.0005	0.0271	0.0017	0.0172	0.0022	0.0358	0.0014	0.0194
INXC	0.0000	0.0317	0.0000	0.1237	0.0000	0.0308	0.0000	0.0197	0.0052	0.0410	-0.0020	0.0220
SNXC	0.0028	0.0411	0.0146	0.1602	-0.0003	0.0400	0.0103	0.0249	0.0000	0.0529	0.0144	0.0277
SBXC	0.0040	0.0468	0.0380	0.1828	-0.0035	0.0455	0.0022	0.0289	0.0000	0.0602	0.0030	0.0326
BAXC	0.1040	0.1691	0.2672	0.6872	0.0704	0.1612	0.1072	0.1026	0.0826	0.2204	0.1165	0.1136
LAXC	0.0156	0.2388	0.0854	0.9280	-0.0008	0.2325	0.0188	0.1489	0.0876	0.3107	-0.0076	0.1675
AUXC	0.0002	0.0090	0.0022	0.0337	-0.0001	0.0089	0.0000	0.0055	0.0000	0.0113	0.0000	0.0062
HGXC	0.0012	0.0067	0.0056	0.0262	0.0004	0.0065	0.0000	0.0042	0.0017	0.0087	-0.0008	0.0047
TLXC	0.0007	0.0063	0.0020	0.0247	0.0002	0.0062	0.0009	0.0040	0.0010	0.0083	0.0009	0.0045
PBXC	0.0197	0.0078	0.0357	0.0301	0.0169	0.0076	0.0104	0.0048	0.0134	0.0099	0.0092	0.0054
URXC	0.0000	0.0078	0.0000	0.0291	0.0000	0.0078	0.0000	0.0053	0.0000	0.0103	0.0000	0.0062

Table 7-4. Source profiles of Summer Paved and Unpaved Road Dust collected in the Treasure Valley, 2001.

Profile Mnemonic	TVRDSUPV						TVRDSUUP					
Season	Summer						Summer					
Sample Type	Paved						Unpaved					
Size	10		2.5		C		10		2.5		C	
	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)
MSGC	100.0000	7.7119	100.0000	7.6173	100.0000	10.3415	100.0000	7.2559	100.0000	7.1005	100.0000	9.4548
CLIC	0.1022	0.0637	0.1823	0.1282	0.0722	0.0740	1.1067	0.1279	0.9968	0.1341	1.1459	0.1693
N3IC	0.0000	0.0441	0.0000	0.0898	0.0000	0.0510	0.0756	0.0306	0.0873	0.0612	0.0717	0.0352
S4IC	0.0934	0.0517	0.0000	0.0898	0.1301	0.0639	0.2146	0.0419	0.2063	0.0871	0.2176	0.0478
N4CC	0.1143	0.0632	0.2481	0.1283	0.0621	0.0729	0.0657	0.0389	0.1735	0.0866	0.0286	0.0430
NAAC	0.0705	0.0493	0.0728	0.0995	0.0709	0.0572	0.1072	0.0315	0.1486	0.0682	0.0931	0.0352
KPAC	0.0823	0.0505	0.1306	0.1011	0.0634	0.0588	0.1228	0.0357	0.2147	0.0736	0.0913	0.0405
OCTC	12.5340	1.7957	13.2725	3.4393	12.2003	2.1096	2.6269	0.9135	1.9464	2.1995	2.8612	0.9687
ECTC	2.2160	0.5142	2.9118	0.8773	1.9580	0.6249	0.0668	0.2645	0.1041	0.5427	0.0537	0.3025
TCTC	14.6109	2.1954	15.5955	4.1370	14.1933	2.5947	2.6046	1.1335	1.6362	2.6493	2.9381	1.2230
NAXC	0.4001	0.9376	0.7237	1.7155	0.2651	1.1341	0.9881	0.6085	1.8409	1.2340	0.6899	0.6970
MGXC	0.1367	0.1036	0.2473	0.1809	0.0966	0.1222	0.1731	0.0450	0.4401	0.0899	0.0805	0.0514
ALXC	3.3787	1.6130	4.5573	0.3469	2.9219	2.2530	3.6152	1.6888	5.4693	0.3879	2.9752	2.2724
SIXC	14.3956	6.4387	18.1151	1.3473	12.9580	8.9656	16.3632	7.4525	21.2623	1.4881	14.6741	10.0452
PHXC	0.0069	0.0255	0.0112	0.0204	0.0047	0.0352	0.0238	0.0247	0.0339	0.0103	0.0204	0.0330
SUXC	0.3172	0.1230	0.3852	0.0340	0.2919	0.1705	0.0724	0.0255	0.1136	0.0137	0.0581	0.0340
CLXC	0.0928	0.0373	0.1114	0.0246	0.0864	0.0528	0.9523	0.3731	1.2013	0.1185	0.8651	0.5027
KPXC	1.6825	0.3325	1.8133	0.1367	1.6328	0.4605	2.0840	0.4182	2.3175	0.1674	2.0032	0.5618
CAXC	1.8016	0.3321	2.0615	0.1753	1.7011	0.4600	1.4356	0.2589	1.5584	0.1192	1.3930	0.3462
TIXC	0.3849	0.0553	0.3346	0.1013	0.4042	0.0671	0.3425	0.0389	0.3221	0.0705	0.3493	0.0466
VAXC	0.0020	0.0303	0.0033	0.0539	0.0015	0.0369	0.0026	0.0228	0.0000	0.0405	0.0035	0.0272
CRXC	0.0122	0.0055	0.0177	0.0114	0.0098	0.0065	0.0096	0.0042	0.0093	0.0096	0.0096	0.0047
MNXC	0.0660	0.0061	0.0745	0.0084	0.0628	0.0078	0.1035	0.0079	0.1114	0.0090	0.1007	0.0102
FEXC	3.8443	0.2982	4.3695	0.3247	3.6410	0.3882	3.3963	0.2582	3.7190	0.2696	3.2844	0.3305
COXC	0.0149	0.0651	0.0164	0.0678	0.0142	0.0867	0.0119	0.0604	0.0156	0.0610	0.0106	0.0784
NIXC	0.0098	0.0020	0.0137	0.0040	0.0083	0.0023	0.0041	0.0012	0.0062	0.0027	0.0034	0.0013
CUXC	0.0090	0.0021	0.0121	0.0041	0.0078	0.0024	0.0041	0.0012	0.0051	0.0028	0.0037	0.0014
ZNXC	0.0716	0.0060	0.0852	0.0077	0.0662	0.0075	0.0158	0.0017	0.0285	0.0035	0.0113	0.0019
GAXC	0.0002	0.0042	0.0010	0.0088	-0.0001	0.0048	0.0005	0.0027	0.0002	0.0061	0.0006	0.0029
ASXC	0.0007	0.0054	0.0000	0.0101	0.0010	0.0064	0.0000	0.0030	0.0000	0.0065	0.0000	0.0034
SEXC	0.0000	0.0022	0.0000	0.0047	0.0000	0.0025	0.0000	0.0014	0.0000	0.0033	0.0000	0.0016
BRXC	0.0001	0.0023	0.0003	0.0047	0.0000	0.0025	0.0101	0.0017	0.0112	0.0033	0.0097	0.0019
RBXC	0.0103	0.0020	0.0108	0.0039	0.0101	0.0023	0.0116	0.0014	0.0116	0.0027	0.0116	0.0017
SRXC	0.0294	0.0031	0.0293	0.0049	0.0295	0.0039	0.0303	0.0027	0.0290	0.0037	0.0308	0.0034
YTXC	0.0023	0.0030	0.0018	0.0066	0.0025	0.0032	0.0025	0.0019	0.0017	0.0047	0.0028	0.0020
ZRXC	0.0141	0.0031	0.0133	0.0063	0.0145	0.0036	0.0143	0.0021	0.0160	0.0044	0.0137	0.0025
MOXC	0.0003	0.0066	0.0004	0.0136	0.0002	0.0075	0.0008	0.0042	0.0003	0.0096	0.0009	0.0046
PDXC	0.0008	0.0161	0.0050	0.0342	-0.0009	0.0182	0.0013	0.0100	0.0013	0.0232	0.0013	0.0109
AGXC	0.0008	0.0195	0.0027	0.0415	-0.0001	0.0221	0.0013	0.0121	0.0032	0.0281	0.0007	0.0131
CDXC	0.0015	0.0207	0.0060	0.0439	-0.0006	0.0234	0.0001	0.0128	0.0005	0.0297	-0.0001	0.0138
INXC	0.0001	0.0235	0.0049	0.0499	-0.0021	0.0266	0.0000	0.0145	0.0000	0.0336	0.0000	0.0157
SNXC	0.0037	0.0295	0.0155	0.0626	-0.0017	0.0333	0.0032	0.0184	0.0215	0.0421	-0.0032	0.0201
SBXC	0.0024	0.0344	0.0115	0.0729	-0.0015	0.0390	0.0026	0.0210	0.0135	0.0479	-0.0012	0.0228
BAXC	0.1051	0.1204	0.1250	0.2641	0.0901	0.1343	0.1292	0.0759	0.1024	0.1790	0.1392	0.0815
LAXC	0.0218	0.1752	0.0359	0.3726	0.0189	0.1978	0.0121	0.1095	0.0231	0.2547	0.0084	0.1182
AUXC	0.0000	0.0072	0.0000	0.0140	0.0000	0.0084	0.0000	0.0042	0.0003	0.0096	-0.0001	0.0045
HGXC	0.0007	0.0049	0.0014	0.0105	0.0004	0.0056	0.0000	0.0031	0.0013	0.0072	-0.0004	0.0033
TLXC	0.0011	0.0047	0.0020	0.0099	0.0007	0.0053	0.0006	0.0029	0.0010	0.0068	0.0004	0.0032
PBXC	0.0162	0.0058	0.0236	0.0121	0.0134	0.0066	0.0067	0.0035	0.0084	0.0081	0.0061	0.0038
URXC	0.0000	0.0059	0.0000	0.0118	0.0000	0.0069	0.0000	0.0042	0.0000	0.0085	0.0000	0.0048

Table 7-5. Source profiles of Winter Sanding material and Summer Chip Sealing material collected in the Treasure Valley, 2001.

Profile Mnemonic	TVRDWISA						TVRDSUCH					
Season	Winter						Summer					
Sample Type	Sanding Material						Chip Material					
Size	10		2.5		C		10		2.5		C	
	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)
MSGC	100.0000	8.1318	100.0000	14.2772	100.0000	9.5347	100.0000	7.8416	100.0000	7.4360	100.0000	10.9758
CLIC	1.6599	0.2767	1.2686	0.6836	1.7597	0.3016	0.1511	0.0557	0.2158	0.0980	0.1207	0.0674
N3IC	0.0000	0.1674	0.0000	0.4701	0.0000	0.1725	0.0470	0.0381	0.0000	0.0679	0.0690	0.0462
S4IC	0.3906	0.1967	0.0000	0.4701	0.4902	0.2165	0.0953	0.0447	0.0000	0.0679	0.1400	0.0579
N4CC	0.1894	0.2373	0.7048	0.6695	0.0578	0.2443	0.0806	0.0541	0.1547	0.0967	0.0458	0.0652
NAAC	1.1356	0.2082	0.9275	0.5315	1.1887	0.2240	0.1427	0.0439	0.1840	0.0766	0.1234	0.0533
KPAC	0.0870	0.1861	0.2086	0.5223	0.0559	0.1918	0.1026	0.0450	0.1555	0.0781	0.0778	0.0549
OCTC	10.0549	5.5236	0.0000	16.9976	12.6213	5.4266	5.7771	1.3332	5.0288	2.4962	6.1278	1.5766
ECTC	1.5977	1.6336	0.0000	4.2091	2.0055	1.7480	0.2014	0.3687	0.3529	0.6085	0.1304	0.4602
TCTC	11.1053	6.9044	0.0000	20.5016	13.9398	6.9261	5.8588	1.6297	4.9236	2.9927	6.2970	1.9462
NAXC	2.4671	1.0127	16.9499	3.0071	-1.2295	1.0921	0.9110	0.3579	3.0557	0.6153	-0.0939	0.4398
MGXC	0.1048	0.3823	0.0000	0.9683	0.1316	0.4113	0.0900	0.1069	0.0828	0.2240	0.0933	0.1167
ALXC	4.2449	2.3504	5.5270	0.6619	3.9176	2.9519	3.6764	1.5846	5.1324	0.3829	2.9927	2.3302
SIXC	17.2325	8.8176	20.9240	2.3486	16.2900	11.0713	16.5283	6.8723	20.8339	1.5287	14.5067	10.1086
PHXC	0.0000	0.0472	0.0147	0.0537	-0.0038	0.0577	0.0167	0.0214	0.0000	0.0242	0.0246	0.0294
SUXC	0.1072	0.0545	0.1504	0.0816	0.0961	0.0651	0.0793	0.0276	0.1036	0.0140	0.0679	0.0400
CLXC	1.7640	0.6260	1.5017	0.2084	1.8310	0.7858	0.1494	0.0431	0.1769	0.0218	0.1364	0.0625
KPXC	1.9459	0.4179	2.1319	0.2595	1.8984	0.5209	2.3060	0.4233	2.6536	0.1956	2.1428	0.6154
CAXC	2.4450	0.6154	3.0106	0.4747	2.3006	0.7627	1.3458	0.2336	1.5355	0.1233	1.2567	0.3382
TIXC	0.3309	0.1769	0.4347	0.5128	0.3043	0.1793	0.3514	0.0477	0.2593	0.0752	0.3946	0.0619
VAXC	0.0030	0.0881	0.0086	0.2448	0.0016	0.0913	0.0059	0.0254	0.0000	0.0382	0.0086	0.0327
CRXC	0.0977	0.0191	0.1942	0.0498	0.0730	0.0204	0.0235	0.0047	0.0295	0.0069	0.0207	0.0060
MNXC	0.0849	0.0128	0.1152	0.0338	0.0772	0.0134	0.1081	0.0091	0.1219	0.0102	0.1017	0.0122
FEXC	3.5713	0.2735	4.4016	0.4963	3.3594	0.3155	4.1316	0.3265	4.6210	0.3390	3.9022	0.4428
COXC	0.0118	0.0607	0.0409	0.0755	0.0043	0.0737	0.0142	0.0712	0.0232	0.0713	0.0100	0.0990
NIXC	0.0402	0.0076	0.0850	0.0221	0.0287	0.0076	0.0150	0.0020	0.0178	0.0031	0.0136	0.0025
CUXC	0.0240	0.0074	0.0304	0.0211	0.0224	0.0075	0.0053	0.0017	0.0110	0.0031	0.0026	0.0020
ZNXC	0.0298	0.0073	0.0231	0.0212	0.0315	0.0075	0.0338	0.0031	0.0384	0.0041	0.0317	0.0041
GAXC	0.0011	0.0154	0.0000	0.0453	0.0013	0.0156	0.0000	0.0036	0.0018	0.0066	-0.0009	0.0042
ASXC	0.0000	0.0168	0.0000	0.0484	0.0000	0.0170	0.0009	0.0050	0.0030	0.0080	0.0000	0.0063
SEXC	0.0000	0.0084	0.0000	0.0247	0.0000	0.0084	0.0000	0.0019	0.0000	0.0036	0.0000	0.0023
BRXC	0.0000	0.0083	0.0000	0.0249	0.0000	0.0083	0.0000	0.0019	0.0000	0.0036	0.0000	0.0023
RBXC	0.0111	0.0069	0.0149	0.0201	0.0102	0.0069	0.0131	0.0019	0.0147	0.0031	0.0123	0.0023
SRXC	0.0331	0.0081	0.0456	0.0231	0.0300	0.0083	0.0268	0.0027	0.0275	0.0038	0.0264	0.0036
YTXC	0.0009	0.0116	0.0000	0.0339	0.0011	0.0116	0.0027	0.0025	0.0013	0.0050	0.0033	0.0029
ZRXC	0.0126	0.0130	0.0130	0.0405	0.0124	0.0127	0.0150	0.0028	0.0156	0.0048	0.0147	0.0034
MOXC	0.0049	0.0239	0.0000	0.0705	0.0061	0.0241	0.0018	0.0056	0.0000	0.0103	0.0027	0.0067
PDXC	0.0000	0.0610	0.0404	0.1794	-0.0103	0.0614	0.0000	0.0136	0.0059	0.0255	-0.0028	0.0160
AGXC	0.0093	0.0728	0.0000	0.2132	0.0117	0.0734	0.0000	0.0167	0.0047	0.0312	-0.0022	0.0196
CDXC	0.0000	0.0782	0.0000	0.2302	0.0000	0.0786	0.0018	0.0174	0.0000	0.0327	0.0027	0.0205
INXC	0.0000	0.0888	0.0000	0.2608	0.0000	0.0895	0.0006	0.0198	0.0000	0.0370	0.0009	0.0233
SNXC	0.0349	0.1127	0.1016	0.3355	0.0179	0.1126	0.0118	0.0251	0.0109	0.0476	0.0122	0.0293
SBXC	0.0162	0.1294	0.0000	0.3802	0.0203	0.1303	0.0051	0.0293	0.0091	0.0546	0.0032	0.0347
BAXC	0.0000	0.4949	0.0613	1.4571	-0.0157	0.4976	0.0670	0.0973	0.1688	0.1827	0.0193	0.1144
LAXC	0.0000	0.6597	0.0000	1.9449	0.0000	0.6628	0.0180	0.1490	0.0000	0.2781	0.0264	0.1758
AUXC	0.0025	0.0239	0.0000	0.0703	0.0031	0.0240	0.0000	0.0056	0.0000	0.0102	0.0000	0.0068
HGXC	0.0017	0.0186	0.0211	0.0551	-0.0032	0.0187	0.0011	0.0042	0.0020	0.0078	0.0007	0.0050
TLXC	0.0026	0.0175	0.0045	0.0516	0.0021	0.0176	0.0011	0.0040	0.0006	0.0075	0.0014	0.0048
PBXC	0.0207	0.0240	0.0393	0.0738	0.0159	0.0236	0.0179	0.0050	0.0234	0.0091	0.0153	0.0059
URXC	0.0000	0.0206	0.0000	0.0603	0.0000	0.0208	0.0000	0.0054	0.0000	0.0092	0.0000	0.0067

Table 7-6. Source profiles of Winter Paved and Unpaved Road Dust collected through the TRAKER inlets in the Treasure Valley, 2001.

Profile Mnemonic	TVRDWITR			
Season	Winter			
Sample Type	TRAKER Sample			
Size	10		2.5	
	Abund. (%)	Unc. (%)	Abund. (%)	Unc. (%)
MSGC	100.0000	7.8039	100.0000	8.8754
CLIC	0.3098	0.2313	-0.0299	0.4117
N3IC	0.0000	0.0075	0.3892	0.0306
S4IC	0.0000	0.0075	0.3892	0.4106
N4CC	0.0202	0.2278	-0.0838	0.4070
NAAC	0.0791	0.0178	0.0144	0.0357
KPAC	0.0966	0.0344	0.1599	0.0616
OCTC	7.8788	3.3868	6.2674	5.9861
ECTC	3.9619	0.5249	1.0379	0.7738
TCTC	11.8406	3.9101	7.2854	6.5755
NAXC	1.8534	2.1621	2.3838	4.8311
MGXC	0.1484	0.4865	-0.0517	0.7465
ALXC	4.4209	4.8333	3.6539	0.3443
SIXC	18.1782	19.9629	17.4841	1.3231
PHXC	-0.0037	0.0871	0.0043	0.0652
SUXC	0.2796	0.0389	0.4190	0.0486
CLXC	0.2233	0.1998	0.1569	0.0389
KPXC	1.5667	0.8698	1.8103	0.1415
CAXC	1.4724	0.7069	2.8629	0.2199
TIXC	0.3397	0.1416	0.2374	0.2709
VAXC	0.0048	0.0930	-0.0049	0.1296
CRXC	0.0081	0.0200	0.0157	0.0150
MNXC	0.0969	0.0101	0.1118	0.0133
FEXC	7.3191	0.5345	9.5696	0.6932
COXC	0.0248	0.1638	0.0376	0.2127
NIXC	0.0039	0.0060	0.0040	0.0114
CUXC	0.0387	0.0059	0.0612	0.0094
ZNXC	0.1323	0.0105	0.0881	0.0080
GAXC	0.0005	0.0133	-0.0059	0.0218
ASXC	0.0000	0.0129	0.0013	0.0202
SEXC	0.0000	0.0059	0.0004	0.0096
BRXC	0.0017	0.0056	-0.0001	0.0097
RBXC	0.0085	0.0056	0.0081	0.0102
SRXC	0.0377	0.0075	0.0227	0.0107
YTXC	0.0026	0.0115	0.0055	0.0184
ZRXC	0.0485	0.0108	0.0598	0.0160
MOXC	0.0007	0.0237	0.0034	0.0378
PDXC	0.0031	0.0303	0.0062	0.0525
AGXC	0.0010	0.0348	0.0022	0.0610
CDXC	0.0017	0.0357	0.0184	0.0573
INXC	-0.0095	0.0423	0.0168	0.0672
SNXC	0.0000	0.0628	0.0000	0.1073
SBXC	0.0098	0.0772	-0.0088	0.1259
BAXC	0.2681	0.2727	0.3808	0.4453
LAXC	0.0529	0.4849	0.0214	0.8044
AUXC	0.0016	0.0196	-0.0095	0.0297
HGXC	0.0003	0.0119	0.0040	0.0196
TLXC	0.0003	0.0113	-0.0004	0.0186
PBXC	0.0158	0.0158	0.0032	0.0340
URXC	0.0006	0.0200	-0.0009	0.0321

8. SUMMARY AND CONCLUSIONS

The Treasure Valley Road Dust Study (TVRDS) investigated the spatial variability, temporal trends, and the effectiveness of control strategies of paved and unpaved road dust emissions in the Ada and Canyon counties of Idaho. The on-site field study occurred in a winter installment between 2/21/01 and 3/17/01 and a summer installment between 7/10/01 and 7/24/01. Supplemental fieldwork was performed at Ft. Bliss, TX during May 2001. Both the winter and the summer on-site field studies included direct measurement of paved and unpaved road dust emissions over the Treasure Valley roadway network using the newly-developed, vehicle based measurement technique (TRAKER) and the collection of road dirt samples for silt analyses. The chemical composition of road dust was characterized to produce site-specific source profiles for use in receptor models.

8.1 Road Dust Distributions, Temporal Trends, Road Sanding, and Control Efficiency

The TRAKER (Testing Re-entrained Aerosol Kinetic Emissions from Roads), a vehicle-based road dust emissions measurement tool, was the workhorse for the TVRDS. It consisted of a box van outfitted with instruments that measure particle concentrations behind the two front tires as well as at a location in front of the bumper. The measurement in front of the bumper provided the background particle concentration near the road surface while the measurements behind the front tires provided a signal related to the road dust emissions. At each measurement location on the vehicle, the instruments included two TSI DustTraks – one with a PM_{10} inlet and one with a $PM_{2.5}$ inlet - and a GRIMM particle size analyzer. The instruments associated with the left front tire were always active, while those associated with the right tire were used when sufficient instrumentation was available. Analysis of TRAKER results employed primarily the data obtained from the left side of the TRAKER vehicle. TRAKER was also equipped with a GPS receiver. The GPS linked every 1-second measurement of road dust with a location on the Treasure Valley roadway network.

The TRAKER signal was calibrated against horizontal road dust flux measurements in Ft. Bliss, TX. This is the same technique used to calibrate the silt loading measurements reported in AP-42 (USEPA, 1999) with the exception that real time particle measurement instrumentation was used in Ft. Bliss. The experiments in Ft. Bliss were conducted on an unpaved road. One Tower was placed upwind of the road and two towers were placed downwind at distances of 9 meters and 50 meters from the road. Each of the towers was equipped with DustTrak monitors using PM_{10} inlets. The upwind tower was additionally equipped with wind speed and direction sensors. Several different vehicles, including the TRAKER were driven over the road at multiple speeds in order to generate dust. The emissions from the road were measured as the horizontal dust flux across each of the two downwind towers.

Two important findings resulted from the tower studies. First, no measurable differences in horizontal dust flux were detected between the two downwind towers. Practically, this meant that little or no PM_{10}-sized dust had settled out while traveling between the 10 m and the 50 m downwind towers. A panel of experts had recently convened and suggested that much of the dust that is emitted from roads settles within a few meters of the road (Watson and Chow, 2000). The panel hypothesized that discrepancies between the dust content of the air as measured by ambient filter samples and the relative magnitude of dust sources as compared with other sources of PM_{10} was due to the rapid settling of dust near the origin of emissions. The results of the Ft.

Bliss experiments were significant because they did not support the hypothesis of the expert panel.

The second important finding from the Ft. Bliss study was that the emissions from the unpaved road increased linearly with the speed of the vehicle traveling on the road. This information was combined with results from separate tests that found the TRAKER signal to be proportional to the speed raised to the third power. Since emissions were related to speed and the signal measured by the TRAKER was related to speed cubed, it was possible to relate the measurement obtained by the TRAKER on any road and speed directly to the emissions potential of that road. This has served as the basis for the TRAKER calibration and it is important to note the associated uncertainties: 1) The emissions tests in Ft. Bliss were conducted on an unpaved road with vehicles traveling at speeds that are substantially lower than normal speeds on paved roads; some changes in the behavior of emissions might be expected at higher speeds; 2) the unpaved road was set in a flat desert landscape with virtually no shrub cover; removal of PM_{10} dust emitted from the road by surface obstructions is minimized. Preliminary modeling conducted in this study indicated that the removal of particles by impaction unto surface obstructions can significantly decrease the effective PM_{10} road dust emissions; and 3) horizontal dust fluxes were only measured up to 50 m downwind of the road dust source; while no reductions were observed in the fluxes of dust between the 10 m and 50 m towers, it is possible that transport on the scale of 1 to 5 km could result in some depletion of the dust that was originally emitted from the road. Indeed, model results discussed in Section 7 indicated that removal of particles emitted at ground level occurs to a significant degree for at least 500 seconds (~500 – 1500 m) downwind of the source.

Assessment of the emissions of road dust has utilized three metrics: The Emissions Potential (b), The Emissions Factor (EF), and the actual Emissions (E). They are related as follows:

$$EF = b \cdot s$$

and

$$E = EF \cdot VKT$$

where s is the speed that vehicles traverse the road in meters per second and VKT is the number of vehicle kilometers traveled. The emissions potential, b, can be thought of as a measure of the inherent “dirtiness” of the road. The emissions factor, EF, is the amount of dust that is suspended by a vehicle traveling 1 km on the road at the normal speed of the road. The actual emissions, E, is the amount of dust suspended by all traffic that passes over the road. With the aid of the calibration curve from Ft. Bliss, TRAKER directly measures the emissions potential (b).

TRAKER was used in three ways as part of the TVRDS. It was used for street surveys, repeated TRAKER “loops”, and special studies.

8.1.1 Distributions of road dust emissions

The TRAKER was used to survey more than 400 km of roads in both winter and summer, 2001. For paved roads, each data point was associated with a link (section of road) in the Traffic Demand Model network for the Treasure Valley. Each link was in turn associated with a number of characteristics. Those included link speed, VKT, county, setting (urban vs. rural), and road class (local/residential, collector, arterial, and interstate). The results of the street survey allowed for assessment of temporal trends in emissions potentials.

Across seasons, counties, settings, and road classes, emissions potentials for paved roads were found to decrease with increasing roadway speeds, though this dependence was not always consistent. At a minimum, the emissions potential decreased inversely with speed (1/s). This was the case for winter emissions potentials on rural roads in Canyon County. The highest sensitivity to speed was observed for summer emissions potentials on rural roads in Canyon County. In this latter case, emissions potentials decrease with speed squared ($1/s^2$). For a few cases in the dataset, a dependence of emissions potentials on traffic volume was also observed, though there was insufficient evidence for drawing firm conclusions.

While higher speed roads were found to have much lower emissions potentials (b), differences in emissions factors (EF) between high and low speed roads were more modest. This implied that the emissions per kilometer traveled on a clean road at high speed could be comparable to those on a dirty road at low speed.

Unlike paved roads, TRAKER surveys of unpaved roads were averaged over all categories because of lack of information on road characteristics. No significant differences were found in emissions from dry unpaved roads between summer and winter. The emissions potential for unpaved roads, 8.6 [g/VKT/mps] was 17 times higher than for the paved road average.

8.1.2 Temporal variations in Road Dust emissions

A set of Ada County roads that constitute a closed circuit was traversed with the TRAKER on multiple occasions during the field study portions of the TVRDS. The TRAKER "loop" was the basis for assessing temporal variations in dust emissions. The loop was performed 7 times in the winter and 5 times in the summer with a separation of two to three days between each circuit.

For paved roads, the emissions potential decreased steadily throughout the winter field study but remained approximately constant throughout the summer field study. This trend was observed for all road classes, though it was more pronounced for low speed roads such as residentials than for high speed roads such as interstates. Considering roads with speed between 17 and 22 m/s (40-49 mph) as an example, emissions potentials on the first loop in winter (2/27/01) were 0.47 g/vkt/mps. By the last winter loop (3/17/01) emissions potentials for those same roads had decreased to 0.37 g/vkt/mps. By the beginning of the summer field study (7/12/01) emissions potentials had dropped to 0.25 g/vkt/mps where they remained for the duration of the summer campaign.

The TRAKER loop included a 1 km section of unpaved road. Analysis of emissions potential from the unpaved road in conjunction with meteorological data indicated that precipitation can suppress dust emissions for two days. Emissions potentials for the unpaved road were 7.9% of the dry road value on the day that the precipitation occurred. On the day following precipitation, emissions potentials had only risen to 35% of the dry road value.

8.1.3 Effect of Road Sanding and effectiveness of Road Dust Controls

The effect of road sanding on road dust emissions was assessed in a controlled experiment. Chinden -a high-traffic road-, and Franklin/Rose Hill -a local, less-traveled- road were each divided into three sections. ACHD applied road sand to all three sections. The first section was swept with a vacuum sweeper, the second was swept with a mechanical broom sweeper, and the third was not swept at all. The TRAKER was used to measure emissions potentials once before sanding and sweeping and several times after sanding and sweeping.

The results of the winter sanding and sweeping experiment indicated that the direct impacts of road sanding on PM_{10} emissions were short-lived, lasting no more than 8 hours or 2500 vehicle passes. PM_{10} emissions potentials increased by 25% to 70% at 2.5 hours after the initial sanding and sweeping. By 8 hours after treatment, the emissions potential from the roads were indistinguishable from their pretreatment levels. Sweeping using a vacuum or mechanical system did not provide any reduction of PM_{10} emissions potential when compared with not sweeping the road. While the sweepers did an excellent job collecting the visible sand on the roads, the systems tested were ineffective at removing the source of the PM_{10} road dust particles. A supplemental test of street sweeper efficiency during the summer field campaign reinforced this conclusion.

8.2 Assembly of Emissions Inventories

Inventories for PM_{10} and $PM_{2.5}$ road dust emissions were assembled for the years 2000, 2010, 2015, and 2020. Paved road inventories for the year 2000 and future years were based on the results of the traffic demand model (TDM) network used by COMPASS for those years. Daily inventories were also created for the periods January 1-9, 1991 and December 20-26, 1999. Additional inventories were calculated using the meteorological conditions corresponding to January 1-9, 1991 in conjunction with the TDM results for the years 2010, 2015, and 2020. For paved roads, VKT and speed data from the TDM were applied to arrive at total emissions per link. The dependence of emissions potentials on speed, county, setting, and season was established with street surveys conducted by TRAKER. Precipitation effects on paved road emissions were accounted for by assuming 30 minutes of zero emissions for each 0.25 mm of precipitation. This assumption was based on visual observation of road wetness after a light rain.

On an annual-average basis, PM_{10} emissions from paved roads were forecasted to increase steadily between the year 2000 and the year 2020. For the years 2010, 2015, and 2020, paved road emissions were respectively 26%, 42%, and 58% higher than the year 2000. Total emissions for the Treasure Valley were 98 metric tons per day, with Ada County roads accounting for 75% (73 tons per day) and Canyon County roads accounting for the remaining 25% (25 tons per day). Segregation of emissions by road class showed that interstates, arterials, collectors, and local/residential roads contributed 19%, 58%, 12%, and 11%, respectively. Average-winter day emissions for the year 2000 were 81 tons per day, 31% higher than annual-average emissions.

Silt loading measurements were performed during the TVRDS to estimate road dust emissions based on EPA's AP-42 methodology (U.S.EPA, 1999). Those silt measurements were performed twice (once in summer and once in Winter) at 9 paved road locations and 3 unpaved road locations. For the winter samples, silt loadings for arterials, collectors, and residential roads were 1.9 g/m^2, 2.9 g/m^2, and 4.0 g/m^2, respectively. These values were compared to the default values recommended by EPA's AP-42 document and used by SAI (1997) to compile an earlier emissions inventory. Compared to the TVRDS silt loadings, EPA's default values for Winter conditions were lower for arterials: 0.5 g/m^2, higher for collectors: 3.0 g/m^2, and lower for residentials: 3.0 g/m^2. Summer silt loadings from the TVRDS were substantially lower than winter samples: 0.5 g/m^2, 0.7 g/m^2, and 0.4 g/m^2 for arterials, collectors, and residentials, respectively. The equivalent EPA default values were lower than the measured Treasure Valley silt loading for arterials: 0.4 g/m^2, higher for collectors: 2.5 g/m^2, and lower for residentials: 2.5 g/m^2. Note that silt measurements were not performed on any interstates during the TVRDS. Therefore, it was not possible to compare on-site silt measurements with the AP-42 default silt loading for interstates (0.02 g/m^2). However, street surveys conducted with the TRAKER indicated that emissions factors from freeways were similar in magnitude to arterials. This suggested that actual silt loadings on interstates in the Treasure Valley should be much higher than the AP-42 default value.

Paved road dust PM_{10} emissions calculated using TRAKER street surveys were compared with estimates from an earlier inventory assembled by SAI (1997) and also with estimates of emissions based on silt measurements conducted as part of the TVRDS. PM_{10} dust emissions from paved roads during an average winter day were estimated using TRAKER street surveys at 81 tons per day. Using the default silt loading for interstates (0.02 g/m^2) and measured silt loadings for the other road classes, average winter emissions were estimated at 58 tons per day. If the silt loading for interstates was assumed to be the same as for arterials - a more representative approximation based on TRAKER street surveys - the emissions estimate increased to 75 tons per day. Note that SAI used AP-42 default silt loadings to arrive at 35 tons per average winter day.

When considered on an annual average basis, estimates of PM_{10} emissions from paved roads by TRAKER street surveys were 62 tons per day. In comparison, silt loadings obtained during the TVRDS yield average emissions of 31 tons per day when default values are used for silt loading on interstates or 41 tons per day when interstate silt loadings are assumed to be the same as those measured on arterials. SAI estimated annual average PM_{10} emissions from paved roads at 31 tons per day.

Unpaved road emissions potentials measured by TRAKER street surveys were averaged to give a value representative for the Treasure Valley. For Ada County, an inventory of unpaved roads, complete with estimates of average speeds and daily traffic was provided by COMPAS and used to estimate rural and urban emissions. For Canyon County, census tract population data was combined with the information received for Ada County and served as a basis for estimating unpaved road characteristics. For Canyon County, additional unpaved road emissions were attributed to small rural townships. Two modifiers were applied to account for meteorological impacts on unpaved road emissions. First, emissions were assumed to be zero during periods when ground snow cover was reported. Second, emissions were set to 7.9% of the dry emissions values on days when precipitation was reported. On days following precipitation, emissions values were set to 35% of the dry emissions values. This treatment of precipitation followed directly from analysis of TRAKER loop data for a 1 km stretch of unpaved road.

In the Treasure Valley PM_{10} emissions inventory assembled as part of this study, TRAKER-based unpaved road emissions were substantially lower than those from paved roads. For average winter conditions, PM_{10} emissions from unpaved road were 2.3 tons per day, 2.8% of the total road dust emissions in the Treasure Valley. On an annual-average basis, unpaved road dust emissions (2.5 tons per day) accounted for a slightly larger fraction of the total road dust emissions (3.9%). Unpaved road emissions estimated in an earlier emissions inventory (SAI, 1997) were comparable for both average winter conditions (2.4 tons per day) and on an annual average basis(2.8 tons per day).

8.3 Differences Between Emissions Measured Roadside and PM_{10} Fluxes on the Grid Scales of Air Quality Models

A simple one-dimensional, time-dependent dispersion model was used to estimate the removal of particles by deposition as a plume of dust is transported downwind of a source. The model was solved numerically for dispersion parameters that correspond to both neutral and stable atmospheric conditions. Particle concentrations were assumed to be uniformly distributed from the ground to a height of 2 m at the time of emission. Particles were subsequently allowed to disperse vertically or deposit at the grid cell nearest the surface (20 cm in height) by a combination of gravitational settling and inertial impaction. The simulation was performed for multiple particle sizes ranging from 1.44 to 9.87 ?m in diameter.

Preliminary results showed that the horizontal flux of 1.44 ?m particles remains relatively constant over transport times on the order of 500 seconds. In contrast, under neutral conditions, fluxes of 9.87 ?m particles were diminished by 28% after 30 seconds (~30 – 90 m downwind of the source) and 64% after 500 seconds (~500 – 1500 m downwind of the source). Stable atmospheric conditions enhanced these reductions to 28% and 74% at 30 seconds and 500 seconds, respectively. Based on the size distribution of road dust emissions obtained during the TVRDS and the assumptions of the model, PM_{10} road dust emissions fluxes measured 500 – 1500 m downwind of a road may be 55 – 65% lower than fluxes measured roadside.

The model input parameters were systematically perturbed to assess the effects of model assumptions. The rate of removal of particles by inertial impaction was found to have a profound effect. In particular, the model indicated that in the absence of inertial impaction, the reduction of horizontal dust flux 500 m downwind of a road compared to roadside is only on the order of 5%. The initial height of the uniformly distributed dust plume was also found to be a significant parameter (2 m in the base case). A decrease in the value of this height enhances particle removal by deposition while an increase has the opposite effect.

8.4 PM_{10} and $PM_{2.5}$ Source Profiles for Road Dust

Silt samples collected during the winter and summer field campaigns of the TVRDS from paved and unpaved roads, samples of road sanding material obtained from ACHD, and samples of material used in Treasure Valley summertime chip-sealing operations were resuspended in a specially-designed chamber. Size-selective inlets were used to collect both the PM_{10} and $PM_{2.5}$ fractions of the resuspended material on Teflon and quartz filters. The filters were analyzed for mass, major ions, ammonium, chemical elements, organic carbon, and elemental carbon. Results of these chemical analyses were used to compile chemical source profiles in the $PM_{2.5}$ and PM_{10} size ranges for paved road dust, unpaved road dust, and road sanding material used by ACHD. The percent content of species on a mass basis, also referred to as the abundance, was used to compare the characteristics of the source profiles.

There were no marked differences between source profiles collected in the winter and those collected in the summer. In both PM_{10} and $PM_{2.5}$ size ranges, all of the samples showed appreciable abundances of elements associated with geologic material: aluminum (Al), silicon (Si), potassium (K), calcium (Ca), and iron (Fe). Abundances of organic and elemental carbon varied amongst samples. For paved road dust, abundances of organic carbon varied between 12% and 16% while those for elemental carbon varied between 1.2% and 2.3%. In contrast, samples from unpaved roads had organic carbon abundances between 2.5% and 4.5% and elemental carbon abundances that were less than 0.1%. The enhanced carbon content of paved roads over unpaved roads was probably due to a combination of tire wear and exhaust particles that have deposited on the road surface. While these two sources of carbon were probably also present on unpaved roads, they were significantly dwarfed by the amount of geologic material that is inherent to the road surface.

Source profiles from road sanding material used by ACHD had 10 to 100 times higher abundances of soluble, sodium, chloride, and sulfate than winter source profiles from paved roads. Material used for summertime chip-sealing had abundances of organic carbon that were 5 to 10 times less than for summer paved road samples. The source profile for chip-sealing material was similar to that from unpaved roads, perhaps making it difficult to distinguish the two during CMB modeling.

8.5 Conclusions

The results of this study have several important implications for road dust emissions. First, the potential of a road to emit dust appears to be highly dependent on the speed of the vehicles traveling on that road. Practically, this means that both the "dirtiness" of the road and the speed at which vehicles travel are important and interconnected factors that control the emissions of particulate matter from roads.

Second, the potential for roads in the Treasure Valley to emit PM_{10} dust is higher in the winter than in the summer. This suggests that there are additional sources of road dust during winter conditions. Wintertime road sanding may contribute to dust emissions. Though low in silt content, sand applied to roads by the ACHD may be pulverized by passing vehicles and potentially serve as a reservoir for PM_{10} emissions. However, tests conducted as part of the TVRDS indicated that road sanding is not likely to be the sole contributor to elevated wintertime road dust emissions. Results from controlled experiments showed that road sanding increases emissions from paved roads for only a few hours before emissions return to their baseline, pre-sanding values. This was found to be true regardless of whether or not the road was cleaned with a street sweeper after sanding. A mass balance approach can be used to reach the same conclusion. Average winter day emissions for Ada County were 64 metric tons per day while annual average emissions were 46 tons per day. Assuming a 90-day winter season, this means that approximately 1,600 additional tons of PM_{10} are emitted during the winter compared to the rest of the year. The sanding schedule shown in Table 4-9 indicates that approximately 1,700 m^3 or 5,100 tons (assuming a density of sand equal to three times that of water) were applied to Ada County roads in the 2000-2001 winter season. In order for the road sand to account for all the excess wintertime PM_{10} road dust emissions, more than one-third (33%) of the sand applied to Ada County roads must be emitted as particles with aerodynamic diameter less than 10?m. Though there are little data on the evolution of the size distributions of road dust over time, it seems highly unlikely that such a large fraction of road sand is emitted as PM_{10}, especially since the sand is usually removed by street sweepers within 48 hours after application. Therefore, there must be a significant source of wintertime road dust other than just road sand applied for traction control.

One possible explanation for elevated emissions is that wetter conditions during the winter are more conducive to the trackout of mud from unpaved lots and driveways unto the paved road network. Tracked mud can serve as a reservoir for PM_{10} emissions. During the summer, when conditions are drier, trackout is expected to have a lesser role. It is not possible to determine at this time what fraction of the elevated wintertime road dust emissions can be attributed to road sanding or to trackout. The ACHD already exercises an aggressive strategy for mitigating the effects of winter road sanding; sand with a low silt content is used and roads are cleaned with streets sweepers within 24 to 48 hours of sand application. Pending the results of future work, this strategy constitutes a good preventive approach. We note that this discussion has focused primarily on Ada County as there is not sufficient information to determine the extent or effects of road sanding in Canyon County.

Third, while street sweepers used in Ada County work well for the removal of large debris and sand-sized grains, they do not appear to have an effect on a given road's potential to emit PM_{10} dust. It is important to stress that the tests conducted as part of this study only considered the short-term benefits of street sweeping. There may be longer-term benefits that are not realized by the type of experiments presented here. However, intensifying street sweeping activities or using different machinery is not recommended until further information about the efficiency of sweepers in reducing PM_{10} emissions has been determined.

Fourth, based on the emissions inventories assembled here and in previous work (SAI, 1997), unpaved road emissions are only a small fraction of total road dust emissions in the Treasure Valley. Thus, treatment of unpaved roads with palliatives or dust suppressants is probably not effective in reducing valley-wide emissions from roads. Note, however, that reducing emissions from unpaved roads can have a significant impact on air quality in the immediate vicinity of that road.

Fifth, emissions inventories based on TRAKER street surveys, TVRDS silt measurements, and default AP-42 values are in remarkably good agreement considering the fundamental differences between the methods used. Both the silt loading and the TRAKER method have been calibrated using the upwind/downwind technique. However, using silt loading as a surrogate for road dust emissions draws on a database of emissions measurements that have been made over the years under a variety of conditions. The TRAKER, on the other hand, uses real-time instruments to measure emissions potentials over a network of roads. The ability of TRAKER to capture these variabilities makes it a useful tool for measurement of location-specific road dust emissions. The TRAKER has the additional advantage that roadway speeds can be accounted for when calculating actual emissions. We note however that the speed-dependent calibration of the TRAKER was performed on an unpaved road at speeds that are substantially lower than those typical for paved roads.

Interestingly, though the silt loading method and the TRAKER method are in reasonable agreement when calculating the Treasure Valley inventory, it is quite likely that both of these methods overstate the amount of dust that is actually transported appreciable distances and then measured by PM_{10} monitors. That is, a disconnect exists between the emissions measurements and the contribution of dust to ambient PM_{10}. This disconnect is well-documented elsewhere (Watson and Chow, 2000; Countess, 2001). As part of the present study, a simplified model was used to assess the magnitude of this disconnect. The preliminary results indicated that horizontal fluxes of PM_{10} can be diminished by as much as 65% within distances on the order of 500–1500 meters downwind of the road.

Sixth, in disagreement with a recent hypothesis put forth by a panel of dust experts (Watson and Chow, 2000), experiments conducted at Ft. Bliss, TX indicate that there is little difference in dust fluxes between 10 meters downwind of a road and 50 meters downwind. It is important to note that the experiments at Ft. Bliss were conducted during daylight hours on a flat, sparsely vegetated landscape and that dust fallout was only measured for distances up to 50 meters from the road. Clearly, dense vegetation and stable nighttime winds may have an effect on dust removal rates. Longer range transport on the order of 1 to 5 km from the point of emission may also result in significant removal of dust particles. Model results from the TVRDS indicated that the removal of particles by impaction is an extremely important pathway for the diminishment of horizontal fluxes of road dust PM_{10}. The model suggested that the fluxes of dust across a horizontal plane continue to decrease appreciably with downwind distances on the order of a kilometer. From the standpoint of emissions and regional scale air quality models, this means that using the emissions factors measured at the side of a road (such as is done in AP-42 as well as the current study) for input in urban or regional-scale air quality models can result in a substantial over-prediction of the contribution of road dust to ambient PM_{10}.

8.6 Areas for Future Research

Future research should focus on the processes that affect dust removal during transport from roads to ambient air quality monitors and the factors that affect the potential of a road to emit dust. A disconnect still exists between the estimates of dust emissions from roads and the amount of dust that is found on filters from ambient PM_{10} samplers. In particular, the effects of vegetation and atmospheric stability conditions on the removal of dust should be investigated. Future tower studies should also examine the horizontal fluxes of dust far from the emissions source (1 – 5 km).

The results of this study showed that the potential of a road to emit dust is related to several factors such as speed, season, and setting. While it is important to know these parameters, it is equally important to understand the mechanisms of where road dust originates from and how it is removed. The TRAKER has been a useful tool in allowing for assessment of some of the factors that contribute to dust emissions. In future studies, data points should be documented and flagged in real-time so that individual measurements are associated with a specific set of road conditions including whether or not the shoulders are paved, the lane of travel of the TRAKER, and the coincidence of a dust-source ingress/egress such as an unpaved road or a construction site.

Re-assessment of the TRAKER signal horizontal flux calibration under paved road conditions is needed. The work performed at Ft. Bliss has demonstrated the utility of using real-time particle sensors for measuring emissions. These measurements should be repeated to obtain more accurate emissions factors for paved roads. Similarly, the relationship between emissions and vehicle weight should be revisited to determine more accurate factors for a variety of vehicle types.

Road dust is a significant source of PM_{10} in the Western United States. However, there is little hard evidence to support the effectiveness of mitigation measures. Therefore, states or counties that are having difficulty meeting the National Ambient Air Quality Standards are forced to implement measures that have uncertain benefits. The most important of these measures is street sweeping. Most metropolitan areas use street sweepers to keep gutters and curbs free of debris. The EPA allows some emissions credits for the use of street sweepers as mitigation of road dust emissions. The effectiveness of street sweepers in reducing PM_{10} emissions remains questionable. It is important to comprehensively evaluate the ability of street sweepers to reduce PM_{10} emissions from roads, including sweepers that have been certified as "PM_{10} efficient" by California Rule 1186.

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APPENDIX A. MAPS OF ROAD DUST COLLECTION AREAS AND SILT LOADING ANALYSIS RESULTS

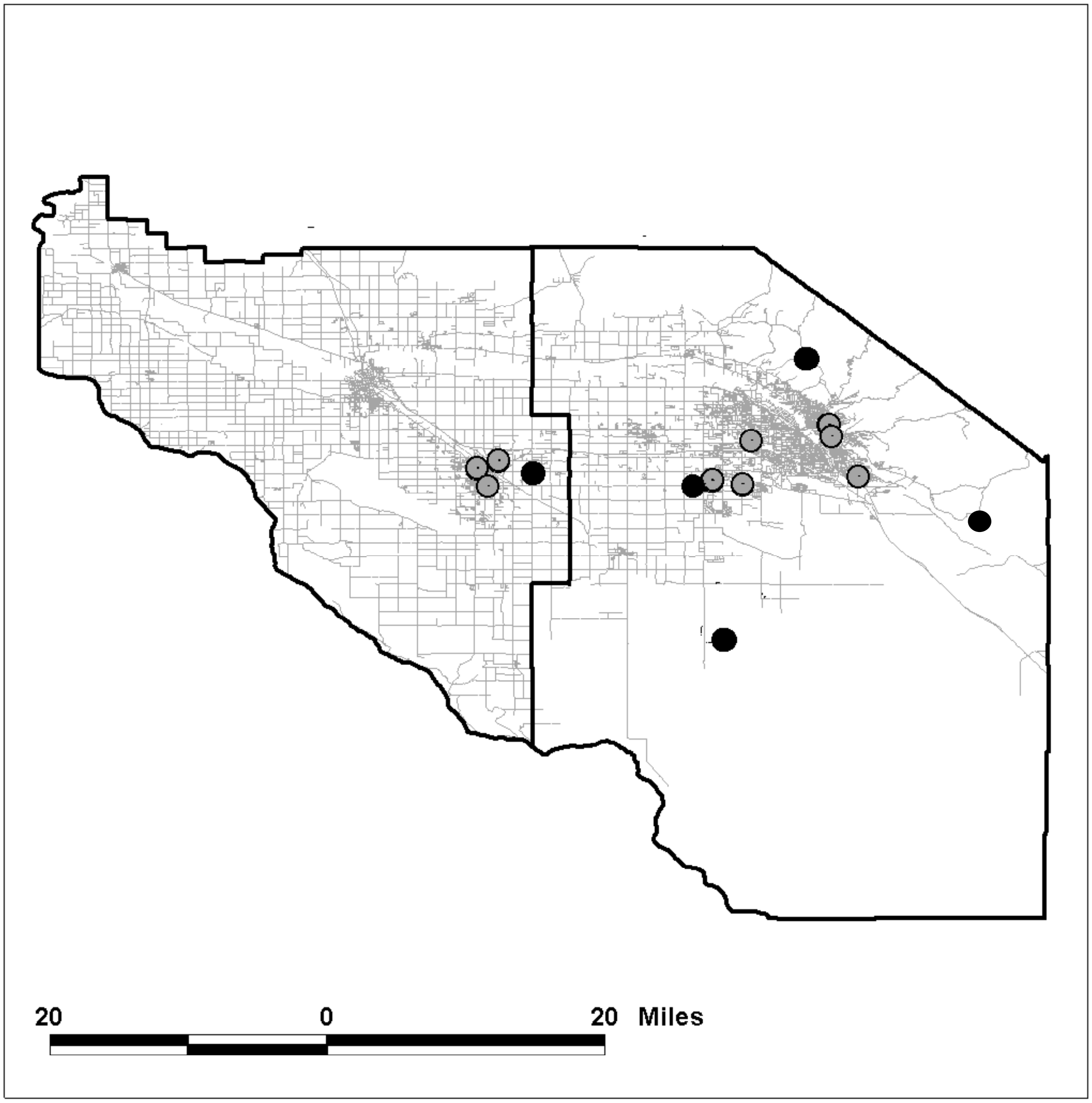

Figure A-1. Map of Sample Collection Locations. Grey circles indicate paved road dust silt sampling. Black circles are locations where unpaved road dust was collected.

Table A-1. Winter 2001 Silt Sampling Locations

Site	Field Sample ID	Lab ID	Sample Date	Type	Width (ft)	Length (ft)	Separation Between Sampling Locations (ft)	Area per sampling location (m2)	Total area for site (m2)	Net Mass per sampling location (g)	Total mass for site (g)
Riva Ridge North of Reutzel Dr.	BOISL001 BOISL002 BOISL003	RS562	3/1/2001	paved	12' 9" 13' 8" 13' 7"	10' 3" 9' 11" 9' 11"	50'	12.1 12.6 12.5	37.2	1568.6 625.6 407	2601
Apple St. Between Wright and LaFayette	BOISL004 BOISL005 BOISL006	RS565	3/3/2001	paved	10' 11" 10' 10" 10' 9"	10' 0" 10' 0" 10' 0"	50'	10.1 10.1 10.0	30.2	199.2 190.1 230.6	620
13th St. North of Hays	BOISL007 BOISL008 BOISL009	RS568	3/4/2001	paved	8' 0" 8' 0" 9' 0"	30' 0" 30' 0" 30' 0"	20'	22.3 22.3 25.1	69.7	133.4 139.9 248.4	522
Front St. Between 3rd and 5th	BOISL010 BOISL011 BOISL012	RS571	3/4/2001	paved	12' 7" 12' 7" 13' 2"	20' 0" 20' 0" 20' 0"	40'	23.4 23.4 24.5	71.2	210.1 298.9 398.3	907
West Park Dr. West of Milwaukee	BOISL013 BOISL014 BOISL015	RS574	3/6/2001	paved	8' 8" 8' 10" 9' 2"	20' 0" 20' 0" 20' 0"	30'	16.1 16.4 17.0	49.5	288.5 228.4 191.5	708
Maple Grove North of Tillamook	BOISL016 BOISL017 BOISL018	RS577	3/6/2001	paved	11' 0" 11' 1" 11' 2"	30' 0" 30' 0" 30' 0"	40'	30.7 30.9 31.1	92.7	174.2 166.9 213.3	554
Garrity Blvd. Between Cavalry and 11th	BOISL019 BOISL020 BOISL021	RS580	3/7/2001	paved	11' 8" 11' 10" 11' 5"	30' 0" 30' 0" 30' 0"	20'	32.5 33.0 31.8	97.3	348 359.3 270.5	978
Amity Between Colorado and Diamond	BOISL022 BOISL023 BOISL024	RS583	3/7/2001	paved	12' 9" 13' 3" 12' 9"	10' 0" 10' 7" 10' 0"	40'	11.8 13.0 11.8	36.7	198.2 218.3 186.3	603
6th St. Between 6th Avenue and 7th Ave	BOISL025 BOISL026 BOISL027	RS586	3/7/2001	paved	11' 4" 11' 4" 11' 4"	20' 0" 20' 0" 20' 0"	20'	21.1 21.1 21.1	63.2	1168.6 1045.3 2129	4343
Howry	BOISL034 BOISL035 BOISL036	RS589	3/6/2001	unpaved	15' 0" 15' 0" 15' 0"	1' 0" 1' 0" 1' 0"	150'	1.4 1.4 1.4	4.2	1566.4 2209.3 3632.1	7408
Cloverdale Farm Road	BOISL037 BOISL038 BOISL039	RS592	3/17/2001	unpaved	15' 0" 15' 0" 15' 0"	1' 0" 1' 0" 1' 0"	100'	1.4 1.4 1.4	4.2	901 1103.5 723.7	2728
Pierce Park	BOISL040 BOISL041 BOISL042	RS595	3/16/2001	unpaved	15' 0" 15' 0" 15' 0"	1' 0" 1' 0" 1' 0"	100'	1.4 1.4 1.4	4.2	1111.4 1466.9 1772.2	4351
Unpaved Driveway Off Happy Valley	BOISL057 BOISL058 BOISL059	RS599	3/7/2001 3/7/2001 3/7/2001	unpaved unpaved unpaved	15' 0" 15' 0" 15' 0"	1' 0" 1' 0" 1' 0"	100'	1.4 1.4 1.4	4.2	1099 837.5 1095.5	3032
ACHD TC Sand	BOISL044	RS598		De-icing grab sample	N/A	N/A	N/A	N/A	N/A	2394	2394

Table A-2. Summer 2001 Silt Sampling Locations

Site	Field Sample ID	Lab ID	Sample Date	Type	Width (ft)	Length (ft)	Separation Between Sampling Locations (ft)	Area per sampling location (m2)	Total area for site (m2)	Net Mass per sampling location (g)	Total mass for site (g)
Riva Ridge North of Reutzel Dr.	BOISL028 BOISL029 BOISL030	RS622	7/12/2001	paved	12' 9" 13' 8" 13' 7"	10' 3" 9' 11" 9' 11"	50'	12.1 12.6 12.5	37.2	1064.5 402 178	1645
Apple St. Between Wright and LaFayette	BOISL053 BOISL054 BOISL055	RS623	7/13/2001	paved	10' 11" 10' 10" 10' 9"	10' 0" 10' 0" 10' 0"	50'	10.1 10.1 10.0	30.2	19 24.7 38	82
13th St. North of Hays	BOISL045 BOISL046 BOISL047	RS624	7/13/2001	paved	8' 0" 8' 0" 9' 0"	30' 0" 30' 0" 30' 0"	20'	22.3 22.3 25.1	69.7	58 58.5 109	226
Front St. Between 3rd and 5th	BOISL061 BOISL062 BOISL063	RS625	7/14/2001	paved	12' 7" 12' 7" 13' 2"	20' 0" 20' 0" 20' 0"	40'	23.4 23.4 24.5	71.2	80 110 123.5	314
West Park Dr. West of Milwaukee	BOISL050 BOISL051 BOISL052	RS626	7/14/2001	paved	8' 8" 8' 10" 9' 2"	20' 0" 20' 0" 20' 0"	30'	16.1 16.4 17.0	49.5	27 16.5 10.5	54
Maple Grove North of Tillamook	BOISL031 BOISL032 BOISL033	RS627	7/12/2001	paved	11' 0" 11' 1" 11' 2"	30' 0" 30' 0" 30' 0"	40'	30.7 30.9 31.1	92.7	32.5 52 51	136
Garrity Blvd. Between Cavalry and 11th	BOISL067 BOISL068 BOISL069	RS628	7/17/2001	paved	11' 8" 11' 10" 11' 5"	30' 0" 30' 0" 30' 0"	20'	32.5 33.0 31.8	97.3	144.5 251.5 142.5	539
Amity Between Colorado and Diamond	BOISL064 BOISL065 BOISL066	RS629	7/17/2001	paved	12' 9" 13' 3" 12' 9"	10' 0" 10' 7" 10' 0"	40'	11.8 13.0 11.8	36.7	75.5 73.5 71	220
6th St. Between 6th Avenue and 7th Ave	BOISL070 BOISL071 BOISL072	RS630	7/17/2001	paved	1' 1' 1'	10' 10' 10'	20'	0.9 0.9 0.9	2.8	550.5 331.5 273	1155
Pierce Park	BOISL073 BOISL074 BOISL075	RS631	7/25/2001	unpaved	15' 0" 15' 0" 15' 0"	1' 0" 1' 0" 1' 0"	150'	1.4 1.4 1.4	4.2		7200
Cloverdale Farm Road	BOISL076 BOISL077 BOISL078	RS632	7/26/2001	unpaved	15' 0" 15' 0" 15' 0"	1' 0" 1' 0" 1' 0"	100'	1.4 1.4 1.4	4.2		1975
Road Near Lucky Peak Dam	BOISL079 BOISL080 BOISL081	RS633	7/25/2001	unpaved	15' 0" 15' 0" 15' 0"	1' 0" 1' 0" 1' 0"	100'	1.4 1.4 1.4	4.2		3135

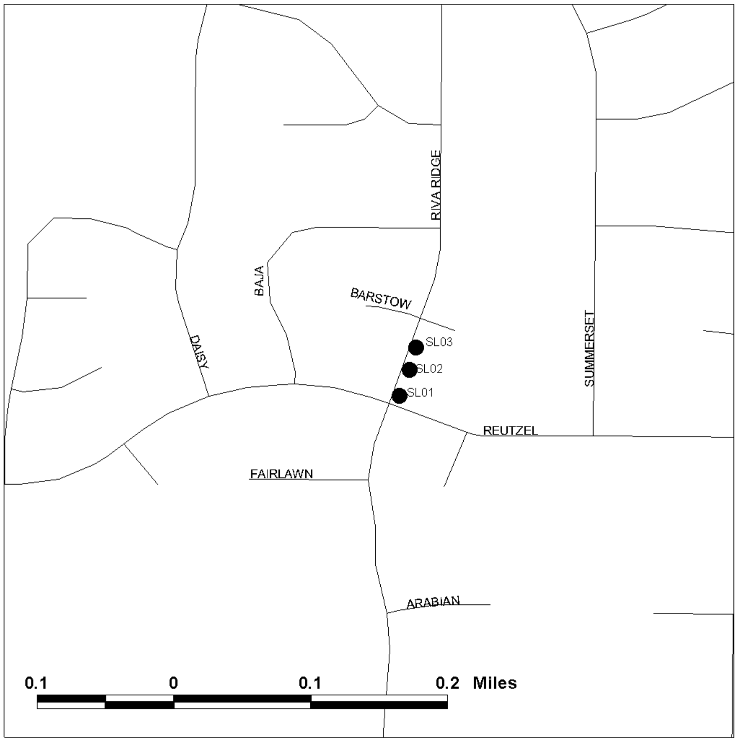

Figure A-2. Map of Silt Loading Location: Riva Ridge North of Reutzel, Boise, ID.

Table A-3. Laboratory Silt Analysis of Winter 2001 Riva Ridge Drive Sample

SAMPLE ID: RS562

Composite:		**Gross Weight**	**Tape**
BOISL001		1610.1	clear
BOISL002		667.1	clear
BOISL003		448.5	clear
	Total	2725.7	

Sieving:	pan	sample	diff	% diff
Tare	343.1			
20 min	355.2	12.1		
30 min	363.7	20.6	8.5	41.3
40 min	366.9	23.8	3.2	13.4

Mass Determination

Screen	**Tare weight (g)** Sieves	**Final Weight(g)** Sieves+sample	**Net weight(g)** Sample
Lid	216.3	216.3	0.0
1/4 inch	490.2	643.2	153.0
4 mesh	444.2	584.6	140.4
18 mesh	371.4	1867.3	1495.9
30 mesh	444.5	745.2	300.7
50 mesh	408.4	660.8	252.4
100 mesh	383.9	467.5	83.6
200 mesh	379.0	434.4	55.4
Pan	343.1	366.9	23.8
Total Stack (calc)	3481.0	5986.2	2505.2
Total Stack (weighed)	3478.7	5984.1	2505.4

Silt Calculation	
Total stack	5984.1
Tare stack	3478.7
Total sample	2505.4
Total silt	23.8
Silt %	0.95

Table A-4. Laboratory Silt Analysis of Summer 2001 Riva Ridge Drive Sample

Date:	8/22/01
Technician:	KAS
Project:BOISE	
Sample	ID:RS622
BOISL028,029,030	
Gross weight of sample 1817.8____________	

Sieving:

	pan	sample	diff	% diff
Tare	698.5			
20 min	730.9	32.4		
30 min	733.5	35	2.6	7.4
40 min	734.4	35.9	0.9	2.5

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	216.1	216	-0.1
1/4 inch	488.9	535	46.1
4 mesh	445.7	477	31.3
18 mesh	369.6	1068.6	699
30 mesh	443.2	785.2	342
50 mesh	408.2	690.7	282.5
100 mesh	383.9	501.6	117.7
200 mesh	378.9	441.2	62.3
Pan (+400*)	698.5	734.4	35.9
Total Stack	3833.4	5449.7	1616.3
Total Stack+sample	5450.2		

Silt Calculation	
Total stack	5449.7
Tare stack	3833.4
Total sample	1616.3
Silt (<200)	35.9
Silt %	2.22

Figure A-3. Map of Silt Loading Location: Apple St. between Wright and LaFayette, Boise, ID.

Table A-5. Laboratory Silt Analysis of Winter 2001 Apple St. Sample

Sample ID: RS565

Composite:		**Gross Weight**	**Tape**
BOISL004		240.7	clear
BOISL005		231.6	clear
BOISL006		272.1	red duct
	Total	744.4	

Sieving:	pan	sample	diff	% diff
Tare	343.1			
20 min	440.8	97.7		
30 min	453.5	110.4	12.7	11.5
40 min	457.4	114.3	3.9	3.4

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	215.9	215.4	-0.5
1/4 inch	488.7	492.6	3.9
4 mesh	444.0	446.7	2.7
18 mesh	369.9	505.5	135.6
30 mesh	444.7	505.8	61.1
50 mesh	409.0	510.5	101.5
100 mesh	383.8	468.7	84.9
200 mesh	379.2	473.6	94.4
Pan	343.1	457.4	114.3
Total Stack	3479.0	3979.8	500.8
Total Stack (with sample)	3979.9		
Total Stack (calc)	3478.3	4076.2	

Silt Calculation	
Total stack	3979.8
Tare stack	3479.0
Total sample	500.8
Total silt	114.3
% Silt (<200)	22.823

Table A-6. Laboratory Silt Analysis of Summer 2001 Apple St. Sample

Date: 8/22/01
Technician:KAS
Project:BOISE
Sample ID:RS623
BOISL053,054,055
Gross weight of sample _250.4___________

Sieving:

	pan	sample	diff	% diff
Tare	698.2			
20 min	709.9	11.7		
30 min	710.5	12.3	0.6	4.9
40 min	711.2	13	0.7	5.4

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	216.2	216	-0.2
1/4 inch	488.9	489.7	0.8
4 mesh	445.8	445.8	0
18 mesh	369.4	383.2	13.8
30 mesh	443.5	448.8	5.3
50 mesh	408.4	416.3	7.9
100 mesh	384	391	7
200 mesh	378.8	387.4	8.6
Pan (+400*)	698.2	711.2	13
Total Stack	3833.3	3889.4	56.1
Total Stack+sample	3890.6		

Silt Calculation	
Total stack	3889.4
Tare stack	3833.3
Total sample	56.1
Silt (<200)	13
Silt %	23.17

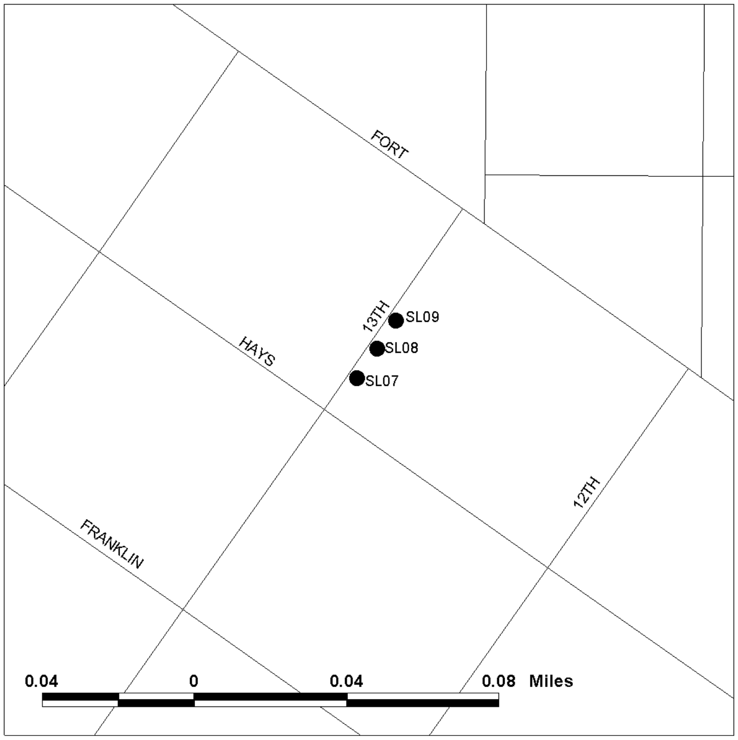

Figure A-4. Map of Silt Loading Location: 13th St North of Hays, Boise, ID.

Table A-7. Laboratory Silt Analysis of Winter 2001 13th St. Sample

Sample ID: RS568

Composite:		**Gross Weight**	**Tape**
BOISL007		174.9	clear
BOISL008		181.4	clear
BOISL009		289.9	clear
	Total	646.2	

Sieving:				
	pan	sample	diff	% diff
Tare	699.2			
20 min	770.6	71.4		
30 min	772.6	73.4	2	2.7
	772.6	73.4		

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	216.5	216.4	-0.1
1/4 inch	489.5	490.5	1
4 mesh	444.7	444.3	-0.4
18 mesh	373.4	411.0	37.6
30 mesh	445.8	486.2	40.4
50 mesh	409.1	478.8	69.7
100 mesh	384.7	470.7	86
200 mesh	379.3	481.5	102.2
Pan + 400	699.2	772.6	73.4
Total Stack	3838.4	4253.0	414.6
Total Stack (with sample)	4253.4		
Total Stack (calc)	3842.2	4252	409.8

Silt Calculation	
Total stack	4253
Tare stack	3838.4
Total sample	414.6
Total silt	73.4
% Silt (<200)	17.704

Table A-8. Laboratory Silt Analysis of Summer 2001 13th St. Sample

Date: 8/27/01
Technician:KAS
Project:BOISE
Sample ID:RS624
BOISL045,046,047
Gross weight of sample 391.6____________

Sieving:	pan	sample	diff	% diff
Tare	698.4			
20 min	725.2	26.8		
30 min	726.9	28.5	1.7	6.0
40 min	0	-698.4	-726.9	104.1

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	216	216	0
1/4 inch	488.9	489.1	0.2
4 mesh	445.8	445.9	0.1
18 mesh	368.9	394.2	25.3
30 mesh	443	477	34
50 mesh	408.6	450.6	42
100 mesh	383.8	413.9	30.1
200 mesh	379.1	413.2	34.1
Pan (+400*)	698.4	727.2	28.8
Total Stack	3832.7	4027.1	194.4
Total Stack+sample	4027.3		

Silt Calculation	
Total stack	4027.1
Tare stack	3832.7
Total sample	194.4
Silt (<200)	28.8
Silt %	14.81

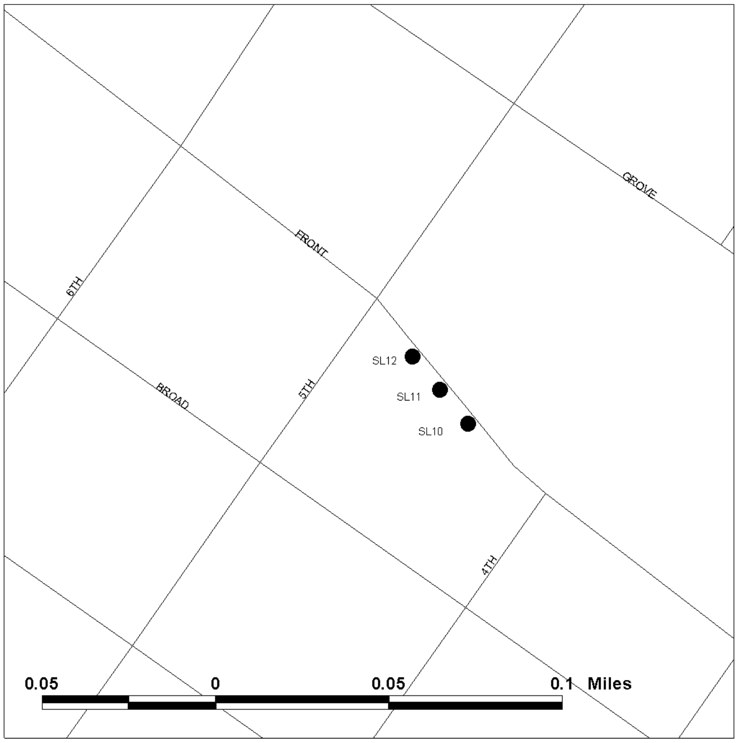

Figure A-5. Map of Silt Loading Location: Front St. between 3rd and 5th, Boise, ID.

Table A-9. Laboratory Silt Analysis of Winter 2001 Front St. Sample

Sample ID: RS571

Composite		Gross Weight	Tape
BOISL010		251.6	clear
BOISL011		340.4	clear
BOISL012		439.8	clear
	Total	1031.8	

Sieving:	pan	sample	diff	% diff
Tare	343.0			
20 min	487.0	144.0		
30 min	505.6	162.6	18.6	11.4
40 min	511.9	168.9	6.3	3.7

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	215.6	215.9	0.3
1/4 inch	489	492.7	3.7
4 mesh	444	448.6	4.6
18 mesh	375.5	590.4	214.9
30 mesh	445	537.1	92.1
50 mesh	408.6	505.2	96.6
100 mesh	384.4	461.4	77
200 mesh	379.3	490.7	111.4
Pan	343	511.9	168.9
Total Stack	3482.9	4251.1	768.2
Total Stack (with sample)	4251.2		
Total Stack (calc)	3484.4	4253.9	769.5

Silt Calculation	
Total stack	4251.1
Tare stack	3482.9
Total sample	768.2
Total silt	168.9
% Silt (<200)	21.986

Table A-10. Laboratory Silt Analysis of Summer 2001 Front St. Sample

Date:8/27/01
Technician:KAS
Project:BOISE
Sample ID:RS625
BOISL061,062,063
Gross weight of sample _438.5___________

Sieving:				
	pan	sample	diff	% diff
Tare	724.7			
20 min	748	23.3		
30 min	748.5	23.8	0.5	2.1
40 min	0	-724.7	-748.5	103.3

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Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	222.5	222.4	-0.1
1/4 inch	488.6	493.9	5.3
4 mesh	445.7	451.2	5.5
18 mesh	368.6	487.8	119.2
30 mesh	431.4	481.8	50.4
50 mesh	405.7	445.5	39.8
100 mesh	378.7	398.3	19.6
200 mesh	376	392.4	16.4
Pan (+400*)	724.7	748.5	23.8
Total Stack	3842.5	4121.8	279.3
Total Stack+sample	4123.1		

Silt Calculation	
Total stack	4121.8
Tare stack	3842.5
Total sample	279.3
Silt (<200)	23.8
Silt %	8.52

Figure A-6. Map of Silt Loading Location: West Park Dr. West of Milwaukee, Boise, ID.

Table A-11. Laboratory Silt Analysis of Winter 2001 West Park Dr. Sample

Sample ID: RS574

Composite		Gross Weight	Tape
BOISL013		331.0	masking
BOISL014		269.9	gray duct
BOISL015		233.0	clear
	Total	833.9	

Sieving:	pan	sample	diff	% diff
Tare	342.8			
20 min	396.8	54.0		
30 min	398.1	55.3	1.3	2.4
40 min	398.6	55.8	0.5	0.9

.

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	215.8	215.9	0.1
1/4 inch	488.7	488.9	0.2
4 mesh	444.0	444.6	0.6
18 mesh	369.6	548.2	178.6
30 mesh	444.4	607.1	162.7
50 mesh	408.1	517.6	109.5
100 mesh	383.6	427.8	44.2
200 mesh	378.7	419.1	40.4
Pan	342.8	398.6	55.8
Total Stack	3479.4	4068.4	589.0
Total Stack (with sample)	4068.5		
Total Stack (calc)	3475.7	4067.8	592.1

Silt Calculation	
Total stack	4068.4
Tare stack	3479.4
Total sample	589.0
Total silt	55.8
% Silt (<200)	9.5

Table A-12. Laboratory Silt Analysis of Summer 2001 West Park Dr. Sample

Date:8/27/01
Technician:KAS
Project:BOISE
Sample ID:RS626
BOISL050,051,052
Gross weight of sample ___180.4_________

Sieving:	pan	sample	diff	% diff
Tare	698.5			
20 min	703.1	4.6		
30 min	704	5.5	0.9	16.4
40 min	704.3	5.8	0.3	5.2

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	216	216	0
1/4 inch	488.9	488.9	0
4 mesh	445.9	445.9	0
18 mesh	367.5	381.7	14.2
30 mesh	443.2	453.1	9.9
50 mesh	408.4	413.3	4.9
100 mesh	384	386.5	2.5
200 mesh	378.9	382.1	3.2
Pan (+400*)	698.5	704.3	5.8
Total Stack	3830.3	3871.8	41.5
Total Stack+sample	3872		

Silt Calculation	
Total stack	3871.8
Tare stack	3830.3
Total sample	41.5
Silt (<200)	5.8
Silt %	13.98

Figure A-7. Map of Silt Loading Location: Maple Grove North of Tillamook, Boise, ID.

Table A-13. Laboratory Silt Analysis of Winter 2001 Maple Grove Sample

Sample ID: RS577

Composite:		**Gross Weight**	**Tape**
BOISL016		215.7	clear
BOISL017		208.4	clear
BOISL018		254.8	clear
	Total	678.9	

Sieving:				
	pan	sample	diff	% diff
Tare	698.3			
20 min	846.7	148.4		
30 min	849.3	151.0	2.6	1.7
	849.3	151.0		

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	215.9	216.2	0.3
1/4 inch	488.6	489.6	1.0
4 mesh	443.8	445.6	1.8
18 mesh	371.5	432.5	61.0
30 mesh	443.9	465.7	21.8
50 mesh	408.1	460.1	52.0
100 mesh	383.6	445.1	61.5
200 mesh	378.9	456.1	77.2
Pan + 400	698.3	849.3	151.0
Total Stack	3834.8	4258.5	423.7
Total Stack (with sample)	4258.4		
Total Stack (calc)	3832.6	4260.2	427.6

Silt Calculation	
Total stack	4258.5
Tare stack	3834.8
Total sample	423.7
Total silt	151.0
% Silt (<200)	35.6

Table A-14. Laboratory Silt Analysis of Summer 2001 Maple Grove Sample

Date: 8/28/01
Technician:KAS
Project:BOISE
Sample ID:RS627
BOISL031,032,033
Gross weight of sample _313.1g___________

Sieving:	pan	sample	diff	% diff
Tare	724.5			
20 min	749.2	24.7		
30 min	749.6	25.1	0.4	1.6
40 min	0	-724.5	-749.6	103.5

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	222	222.5	0.5
1/4 inch	488.9	489.1	0.2
4 mesh	445.9	446.4	0.5
18 mesh	368.5	398.9	30.4
30 mesh	431.3	445.3	14
50 mesh	405.9	418.3	12.4
100 mesh	378.6	389.5	10.9
200 mesh	375.8	388.6	12.8
Pan (+400*)	724.5	749.6	25.1
Total Stack	3841.4	3948.2	106.8
Total Stack+sample	3948.4		

Silt Calculation	
Total stack	3948.2
Tare stack	3841.4
Total sample	106.8
Silt (<200)	25.1
Silt %	23.50

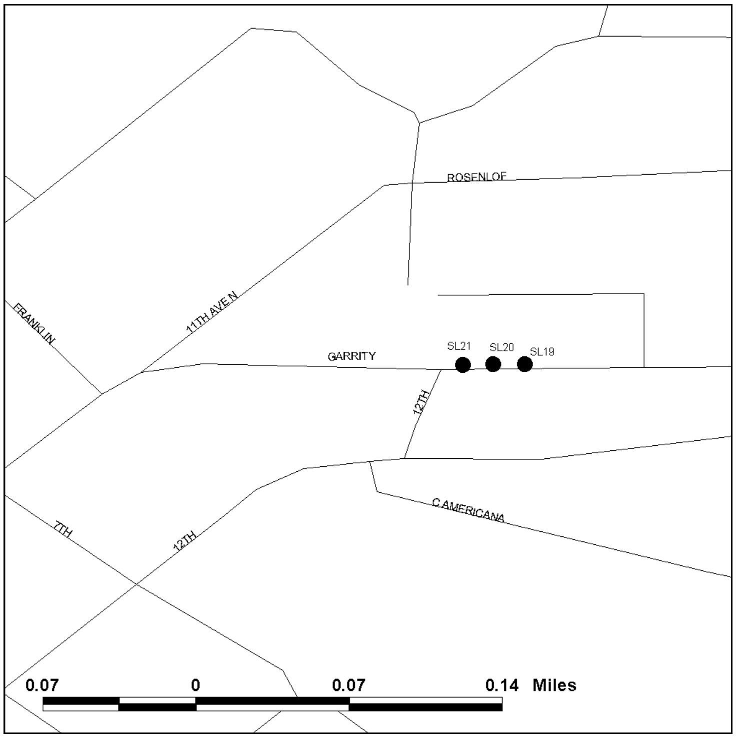

Figure A-8. Map of Silt Loading Location: Garrity Blvd. between Calvary and 11th, Nampa, ID.

Table A-15. Laboratory Silt Analysis of Winter 2001 Garrity Blvd Sample

Sample ID: RS580

Composite:		**Gross Weight**	**Tape**
BOISL019		389.5	clear
BOISL020		400.8	clear
BOISL021		312.0	clear
	Total	1102.3	

Sieving:	pan	sample	diff	% diff
Tare	698.6			
20 min	771.0	72.4		
30 min	774.5	75.9	3.5	4.6
40 min	777.6	79.0	3.1	3.9

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	216.1	216.1	0.0
1/4 inch	489.3	493.0	3.7
4 mesh	443.9	444.5	0.6
18 mesh	371.3	484.2	112.9
30 mesh	444.4	616.2	171.8
50 mesh	408.8	626.9	218.1
100 mesh	383.9	540.6	156.7
200 mesh	379.1	509.9	130.8
Pan + 400	698.6	777.6	79.0
Total Stack	3834.7	4709.3	874.6
Total Stack (with sample)	4709.5		
Total Stack (calc)	3835.4	4709.0	873.6

Silt Calculation	
Total stack	4709.3
Tare stack	3834.7
Total sample	874.6
Total silt	79.0
% Silt (<200)	9.0

Table A-16. Laboratory Silt Analysis of Summer 2001 Garrity Blvd Sample

Date:	8/28/01
Technician:	KAS
Project:BOISE	
Sample	ID:RS628
BOISL067,068,069	
Gross weight of sample ___692.3g_________	

Sieving:	pan	sample	diff	% diff
Tare	698.5			
20 min	773.8	75.3		
30 min	775.9	77.4	2.1	2.7
40 min	0	-698.5	-775.9	111.1

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Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	216	216	0
1/4 inch	488.9	493.4	4.5
4 mesh	445.9	450.4	4.5
18 mesh	367.8	478.1	110.3
30 mesh	443	549.6	106.6
50 mesh	408.4	520.7	112.3
100 mesh	383.5	443	59.5
200 mesh	379	416.3	37.3
Pan (+400*)	698.5	775.9	77.4
Total Stack	3830.8	4343.4	512.6
Total Stack+sample	4334.4		

Silt Calculation	
Total stack	4343.4
Tare stack	3830.8
Total sample	512.6
Silt (<200)	77.4
Silt %	15.10

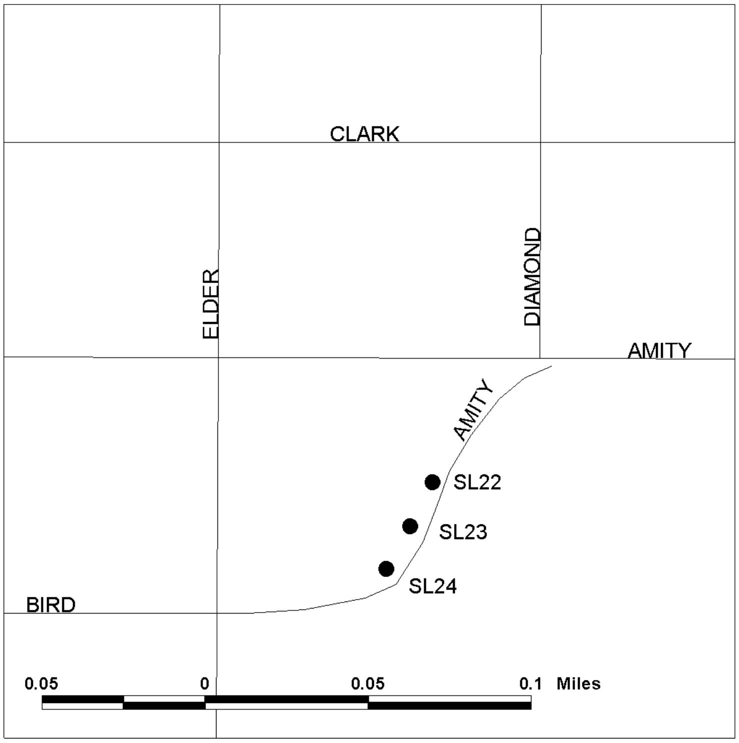

Figure A-9. Map of Silt Loading Location: Amity between Colorado and Diamond, Nampa, ID.

Table A-17. Laboratory Silt Analysis of Winter 2001 Amity Sample

Sample ID: RS583

Composite:		Gross Weight	Tape
BOISL021		239.7	clear
BOISL022		259.8	clear
BOISL023		227.8	clear
	Total	727.3	

Sieving:	pan	sample	diff	% diff
Tare	698.8			
20 min	873.7	174.9		
30 min	879.1	180.3	5.4	3.0
40 min	879.1	180.3		

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	216.2	215.8	-0.4
1/4 inch	489.3	490.0	0.7
4 mesh	444.4	446.5	2.1
18 mesh	372.1	420.3	48.2
30 mesh	444.3	472.5	28.2
50 mesh	409.1	453.8	44.7
100 mesh	384.2	431.9	47.7
200 mesh	379.4	472.3	92.9
Pan + 400 mesh	698.8	879.1	180.3
Total Stack	3835.7	4282.2	446.5
Total Stack (with sample)	4283.0		
Total Stack (calc)	3837.8	4282.2	444.4

Silt Calculation	
Total stack	4282.2
Tare stack	3835.7
Total sample	446.5
Total silt	180.3
% Silt (<200)	40.4

Table A-18. Laboratory Silt Analysis of Summer 2001 Amity Sample

Date:8/28/01
Technician:KAS
Project:BOISE
Sample ID:RS629
BOISL064,065,066
Gross weight of sample __373.4__________

Sieving:	pan	sample	diff	% diff
Tare	724.4			
20 min	742.8	18.4		
30 min	744.8	20.4	2	9.8
40 min	745.6	21.2	0.8	3.8

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	222.2	222.2	0
1/4 inch	488.9	498.5	9.6
4 mesh	445.9	454.1	8.2
18 mesh	368.3	420.2	51.9
30 mesh	431	455.1	24.1
50 mesh	405.9	440.5	34.6
100 mesh	378.3	403.9	25.6
200 mesh	375.8	395.7	19.9
Pan (+400*)	724.4	745.6	21.2
Total Stack	3840.9	4035.8	194.9
Total Stack+sample	4036.8		

Silt Calculation	
Total stack	4035.8
Tare stack	3840.9
Total sample	194.9
Silt (<200)	21.2
Silt %	10.88

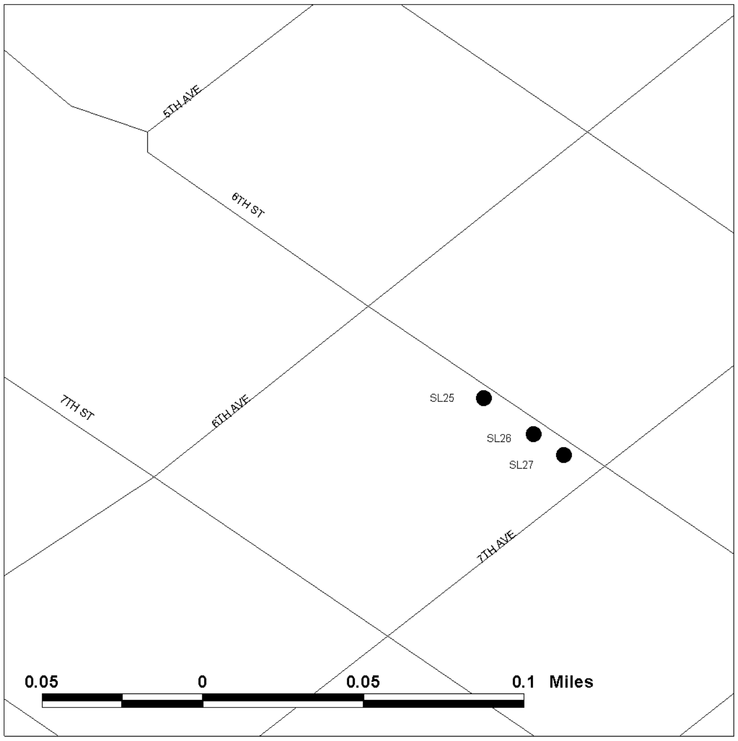

Figure A-10. Map of Silt Loading Location: 6th St. between 6th Ave and 7th Ave, Nampa, ID.

Table A-19. Laboratory Silt Analysis of Winter 2001 6th St. Sample

Sample ID: RS586

Composite:		**Gross Weight**	**Tape**
BOISL025		1210.1	clear
BOISL026		1086.8	clear
BOISL027		2170.5	clear
	Total	4467.4	

Sieving:				
	pan	sample	diff	% diff
Tare	698.3			
20 min	814.9	116.6		
30 min	853.0	154.7	38.1	24.6
40 min	0.0	-698.3	-853.0	122.2

Mass Determination			
Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	215.8	216.1	0.3
1/4 inch	489.1	499.7	10.6
4 mesh	443.9	452.0	8.1
18 mesh	371.2	574.7	203.5
30 mesh	444.3	843.8	399.5
50 mesh	408.8	1179.5	770.7
100 mesh	384.2	647.3	263.1
200 mesh	378.9	657.1	278.2
Pan + 400	698.3	879.5	181.2
Total Stack	3834.6	5948.7	2114.1
Total Stack (with sample)	5948.8		
Total Stack (calc)	3834.5	5949.7	2115.2

Silt Calculation	
Total stack	5948.7
Tare stack	3834.6
Total sample	2114.1
Total silt	181.2
% Silt (<200)	8.6

Table A-20. Laboratory Silt Analysis of Summer 2001 6th St. Sample

Date:8/29/01
Technician:KAS
Project:BOISE
Sample ID:RS630
BOISL070,071,072
Gross weight of sample _1308.1g
____

Sieving:	pan	sample	diff	% diff
Tare	698.6			
20 min	711.5	12.9		
30 min	712.4	13.8	0.9	6.5
40 min	712.5	13.9	0.1	0.7

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	216	216	0
1/4 inch	488.8	833.5	344.7
4 mesh	445.8	641.9	196.1
18 mesh	368.1	748.2	380.1
30 mesh	442.9	514.5	71.6
50 mesh	408.4	481.8	73.4
100 mesh	383.7	422.7	39
200 mesh	378.9	402.2	23.3
Pan (+400*)	698.6	712.5	13.9
Total Stack	3831.3	4973.3	1142
Total Stack+sample	4973.5		

Silt Calculation	
Total stack	4973.3
Tare stack	3831.3
Total sample	1142
Silt (<200)	13.9
Silt %	1.22

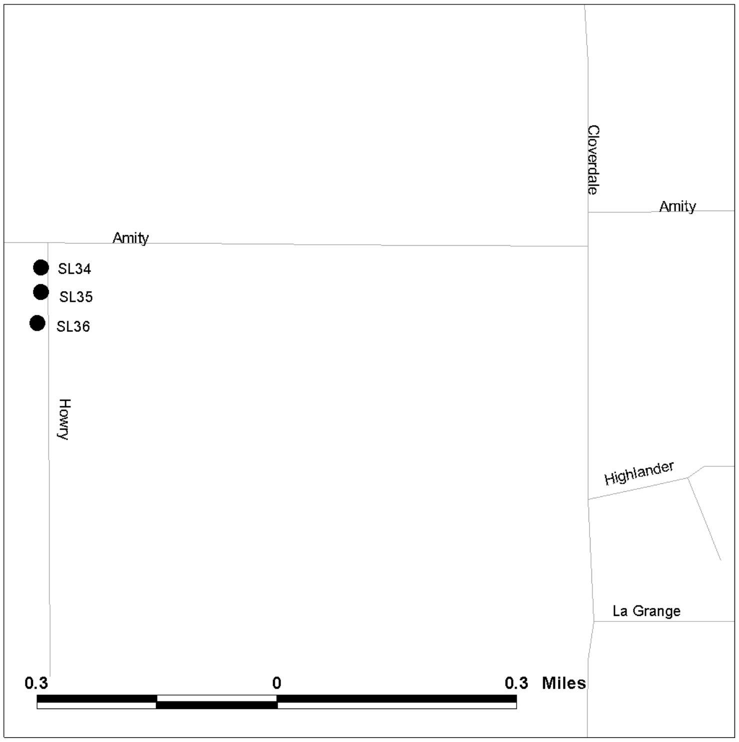

Figure A-11. Sampling locations of unpaved road material: Howry Road, Ada County, ID.

Table A-21. Laboratory Silt Analysis of Winter 2001 Howry Sample

Sample ID: RS589

Composite:		**Gross Weight**	**Tape**
BOISL034		1570.4	na
BOISL035		2213.3	na
BOISL036		3636.1	na
	Total	7419.8	

Sieving:				
splitter used before silt	pan	sample	diff	% diff
Tare	698.6			
20 min	715.4	16.8		
30 min	735.9	37.3	20.5	55.0
40 min	741.1	42.5	5.2	12.2

Mass Determination			
Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	215.8	216.3	0.5
1/4 inch	489.2	1072.3	583.1
4 mesh	444.2	647.2	203.0
18 mesh	370.6	1691.2	1320.6
30 mesh	444.1	1235.0	790.9
50 mesh	408.4	1171.2	762.8
100 mesh	383.9	449.8	65.9
200 mesh	378.8	433.6	54.8
Pan + 400	698.6	741.1	42.5
Total Stack	3833.1	7656.4	3823.3
Total Stack (with sample)	7656.7		
Total Stack (calc)	3833.6	7657.7	3824.1

Silt Calculation	
Total stack	7656.4
Tare stack	3833.1
Total sample	3823.3
Total silt	42.5
% Silt (<200)	1.1

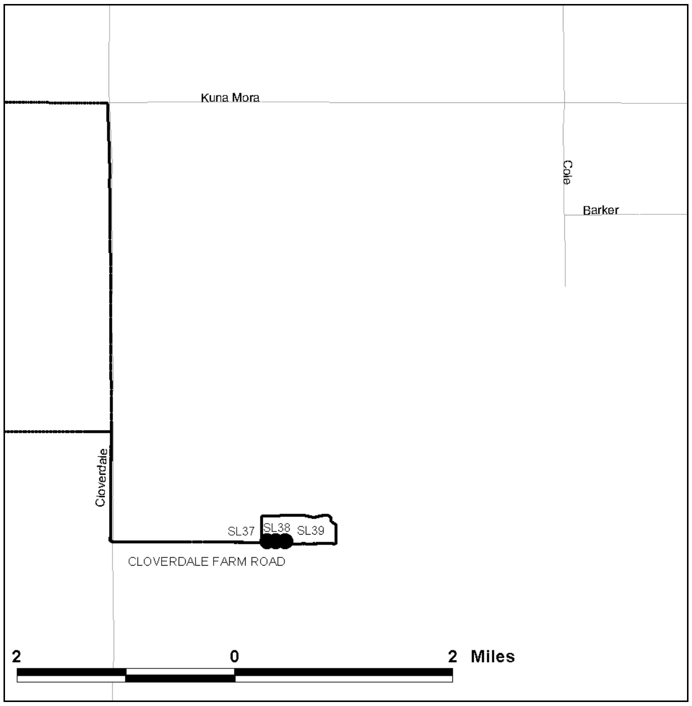

Figure A-12. Sampling locations of unpaved road material: Cloverdale Farm Road, Ada County, ID.

Table A-22. Laboratory Silt Analysis of Winter 2001 Cloverdale Farm Road Sample

Sample ID: 592

Composite:		**Gross Weight**	**Tape**
BOISL037		918.0	NA
BOISL039		1107.5	NA
BOISL040		727.7	NA
	Total	2753.2	

Sieving:	pan	sample	diff	% diff
Tare	698.5			
20 min	727.2	28.7		
30 min	729.6	31.1	2.4	7.7
40 min	731.2	1.6	0.8	2.6

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	216.0	5215.8	4999.8
1/4 inch	489.0	943.5	454.5
4 mesh	444.3	554.5	110.2
18 mesh	371.9	1052.7	680.8
30 mesh	443.8	606.6	162.8
50 mesh	408.6	513.0	104.4
100 mesh	384.2	413.7	29.5
200 mesh	379.4	398.1	18.7
Pan + 400	698.5	731.2	32.7
Total Stack	3835.1	5429.7	1594.6
Total Stack (with sample)	1.0		
Total Stack (calc)	3835.7	10429.1	6593.4
	5429.9		

Silt Calculation	
Total stack	5429.7
Tare stack	3835.1
Total sample	1594.6
Total silt	32.7
% Silt (<200)	2.1

Table A-23. Laboratory Silt Analysis of Summer 2001 Cloverdale Farm Road Sample

Date:8/29/01
Technician:KAS
Project:BOISE
Sample ID:RS632
BOISL076,077,078
Gross weight of sample ____________

Sieving:	pan	sample	diff	% diff
Tare	698.5			
20 min	743.5	45		
30 min	759.2	60.7	15.7	25.9
40 min	779.6	81.1	20.4	25.2

.

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	216	216	0
1/4 inch	488.9	769.2	280.3
4 mesh	445.6	512.5	66.9
18 mesh	369.3	1379.7	1010.4
30 mesh	443	685.1	242.1
50 mesh	408.2	614.9	206.7
100 mesh	383.6	423.5	39.9
200 mesh	378.8	427.6	48.8
Pan (+400*)	698.5	779.6	81.1
Total Stack	3833	5808.1	1975.1
Total Stack+sample	5807.8		

Silt Calculation	
Total stack	5808.1
Tare stack	3833
Total sample	1975.1
Silt (<200)	81.1
Silt %	4.11

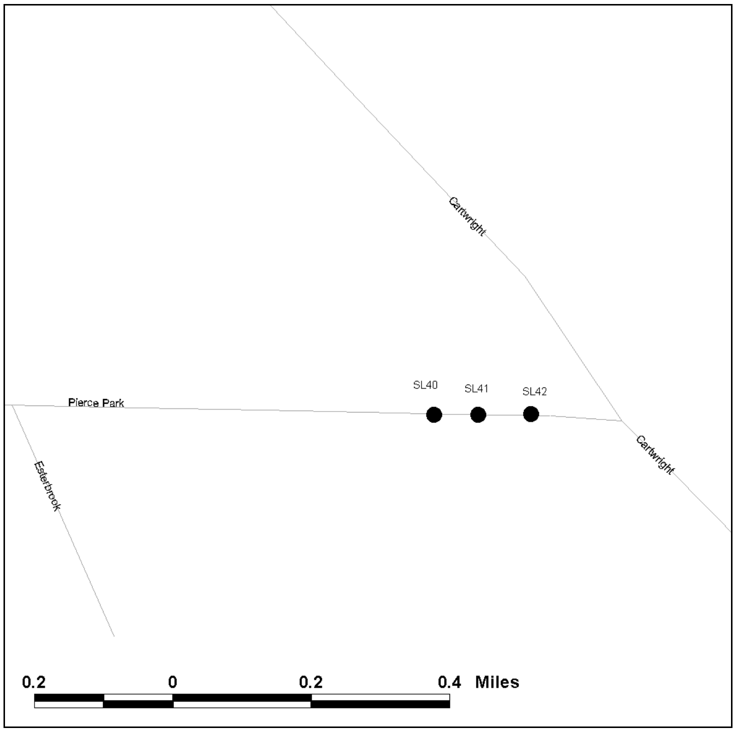

Figure A-13. Sampling locations of unpaved road material: Pierce Park Road, Ada County, ID.

Table A-24. Laboratory Silt Analysis of Winter 2001 Pierce Park Sample

Sample ID: RS595

Composite:		**Gross Weight**	**Tape**
BOISL040		1115.4	na
BOISL041		1470.9	na
BOISL042		1776.2	na
	Total	4362.5	

Sieving:				
splitter used before silt	pan	sample	diff	% diff
Big rocks removed (79.7g)				
Tare	698.1			
20 min	703.4	5.3		
30 min	704.2	6.1	0.8	13.1
40 min	705.8	7.7	1.6	20.8

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	216.2	216.1	-0.1
1/4 inch	489.6	559.3	69.7
4 mesh	444.5	470.7	26.2
18 mesh	371.8	1076.0	704.2
30 mesh	444.6	562.1	117.5
50 mesh	409.4	442.4	33.0
100 mesh	384.0	391.8	7.8
200 mesh	378.9	380.4	1.5
Pan + 400	698.1	705.8	7.7
Total Stack	3834.6	4803.6	969.0
Total Stack (with sample)	4803.8		
Total Stack (calc)	3837.1	4804.6	967.5

Silt Calculation	
Total stack	4803.6
Tare stack	3834.6
Total sample	969.0
Total silt	7.7
% Silt (<200)	0.8

Table A-25. Laboratory Silt Analysis of Summer 2001 Pierce Park Sample

Date:8/29/01
Technician:KAS
Project:BOISE
Sample ID:RS631
BOISL073,074,075
Gross weight of sample: 1801.0g 1/4 of the sample

Sieving:	pan	sample	diff	% diff
Tare	724.5			
20 min	750.5	26		
30 min	751.2	26.7	0.7	2.6
40 min	0	-724.5	-751.2	103.7

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	222.5	22.5	-200
1/4 inch	488.9	582.2	93.3
4 mesh	445.9	472.8	26.9
18 mesh	369	1198.4	829.4
30 mesh	430.6	782.1	351.5
50 mesh	406.2	894.2	488
100 mesh	378.3	510.5	132.2
200 mesh	376.1	424	47.9
Pan (+400*)	724.5	751.2	26.7
Total Stack	3841.5	5637.9	1796.4
Total Stack+sample	5637.9		

Silt Calculation	
Total stack	5637.9
Tare stack	3841.5
Total sample	1796.4
Silt (<200)	26.7
Silt %	1.49

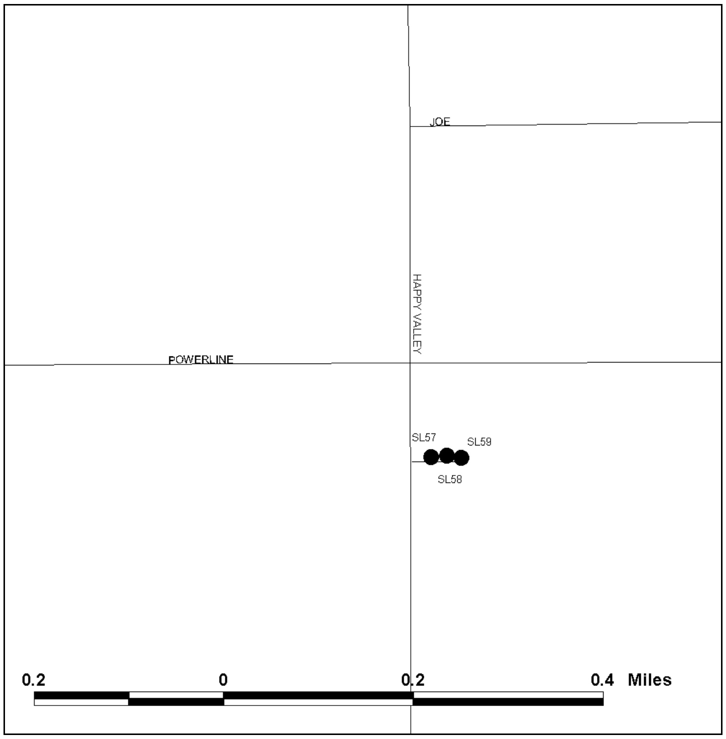

Figure A-14. Sampling locations of unpaved road material: Unpaved Driveway Off Happy Valley Road, Canyon County, ID.

Table A-26. Laboratory Silt Analysis of Winter 2001 Sample from Unpaved Driveway Off Happy Valley

Sample ID: RS599

Composite:		**Gross Weight**	**Tape**
BOISL057		1108.5	na
BOISL058		837.0	na
BOISL059		1094.4	na
	Total	3039.9	

Sieving:				
splitter used before silt	pan	sample	diff	% diff
Tare	698.6			
20 min	720.9	22.3		
30 min	721.6	23.0	0.7	3.0
40 min	721.6	23.0		

Mass Determination			
Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	216.0	215.9	-0.1
1/4 inch	488.9	537.7	48.8
4 mesh	444.0	481.5	37.5
18 mesh	372.5	1149.0	776.5
30 mesh	445.0	782.3	337.3
50 mesh	409.3	575.1	165.8
100 mesh	384.0	421.2	37.2
200 mesh	379.2	398.1	18.9
Pan + 400	698.6	721.6	23.0
Total Stack	3836.7	5283.6	1446.9
Total Stack (with sample)	5284.7		
Total Stack (calc)	3837.5	5282.4	1444.9

Silt Calculation	
Total stack	5283.6
Tare stack	3836.7
Total sample	1446.9
Total silt	23.0
% Silt (<200)	1.6

Table A-27. Laboratory Silt Analysis of Summer 2001 Sample from Unpaved road near Lucky Peak Dam. Map unavailable.

Date: 8/30/01
Technician:KAS
Project:BOISE
Sample ID:RS633
BOISL079,080,081
Gross weight of sample __3135.4g (only 1/2 of sample used)

Sieving:	pan	sample	diff	% diff
Tare	724.7			
20 min	800.3	75.6		
30 min	802.1	77.4	1.8	2.3
40 min	0	-724.7	-802.1	110.7

Mass Determination

Screen	Tare weight (g)	Final Weight(g)	Sample weight(g)
Lid	222.4	222.4	0
1/4 inch	488.5	566.2	77.7
4 mesh	445.9	506.1	60.2
18 mesh	369.1	1138.4	769.3
30 mesh	430.5	721.1	290.6
50 mesh	405.9	602.5	196.6
100 mesh	378.3	466.9	88.6
200 mesh	375.9	428.4	52.5
Pan (+400*)	724.7	802.1	77.4
Total Stack	3841.8	5454.1	1612.3
Total Stack+sample	5454.3		

Silt Calculation	
Total stack	5454.1
Tare stack	3841.8
Total sample	1612.3
Silt (<200)	77.4
Silt %	4.80

Table A-28. Laboratory Silt Analysis of Sample of Road Sanding Material Procured from the Ada County Highway District

Sample ID: RS598

Composite:	**Gross Weight**	**Tape**
BOISL044: predry	2398.0	
BOISL044:postdry	2217.1	

Sieving:				
	pan	sample	diff	% diff
Tare	698.4			
20 min	699.3	0.9		
30 min	704.4	6.0	5.1	85.0
40 min	704.9	6.5	0.5	7.7

Mass Determination			
Screen	Tare weight (g)	Final Weight(g)	Net weight(g)
Lid	215.9	215.9	0.0
1/4 inch	488.9	506.2	17.3
4 mesh	444.1	506.9	62.8
18 mesh	372.9	2282.8	1909.9
30 mesh	444.4	501.6	57.2
50 mesh	408.3	473.8	65.5
100 mesh	383.6	457.8	74.2
200 mesh	378.5	400.6	22.1
Pan + 400	698.4	704.9	6.5
Total Stack	3835.5	6048.0	2212.5
Total Stack (with sample)	6048.0		
Total Stack (calc)	3835.0	6050.5	2215.5

Silt Calculation	
Total stack	6048.0
Tare stack	3835.5
Total sample	2212.5
Total silt	6.5
% Silt (<200)	0.3

APPENDIX B. BOISE PRECIPITATION AND WIND SPEED SUMMARY

B.1 Precipitation

Daily precipitation data is summarized for the Boise airport for the period Jan 1940-October 2001. Hourly wind speed data is summarized for the period January 1988-December 1994.

Average annual precipitation for the period 1940-2000 is 11.88" with a standard deviation of 2.43 inches. Maximum annual precipitation was 18.77" in 1983; minimum was 6.64 " in 1966. Table B-1 gives the fraction of days with precipitation 0.01" or more, the average daily precipitation, and the average precipitation for days with measurable precipitation.

Table B-1. Summary of precipitation statistics by month, Boise airport January 1940-October 2001.

Month	Fraction of days with 0.25 mm or more precipitation	Average daily precipitation (inches)	Average daily precipitation when >0
Jan	0.38	1.17	0.12
Feb	0.36	1.04	0.11
Mar	0.31	1.02	0.13
Apr	0.28	1.02	0.15
May	0.25	1.04	0.16
Jun	0.20	0.74	0.15
Jul	0.08	0.23	0.11
Aug	0.08	0.23	0.12
Sep	0.12	0.51	0.16
Oct	0.19	0.66	0.14
Nov	0.34	1.14	0.13
Dec	0.37	1.12	0.12
Annual	0.25	0.81	0.13

Table B-1 shows that the frequency of precipitation peaks during winter, with November through February having measurable precipitation on more than one-third of the days. There is a gradual drop off in precipitation frequency in the spring. In July and August only 8% of the days have measurable values. Precipitation in September is also relatively infrequent; October is a transition month with frequency about mid-way between winter and summer. As precipitation amounts are typically somewhat higher for days in the spring compared to winter, average daily precipitation is relatively constant from November through May, even through the frequency of precipitation days decreases in spring. On a yearly average basis, 25% of the days have measurable amounts, with an average of 0.13" on those days. Figure 1 shows a cumulative frequency distribution of amounts for days with measurable precipitation (25% of all days). About 50% of the days with precipitation have less than 0.08". Nearly 25% have only 0.01-0.02". 11% of the days with precipitation have >0.30".

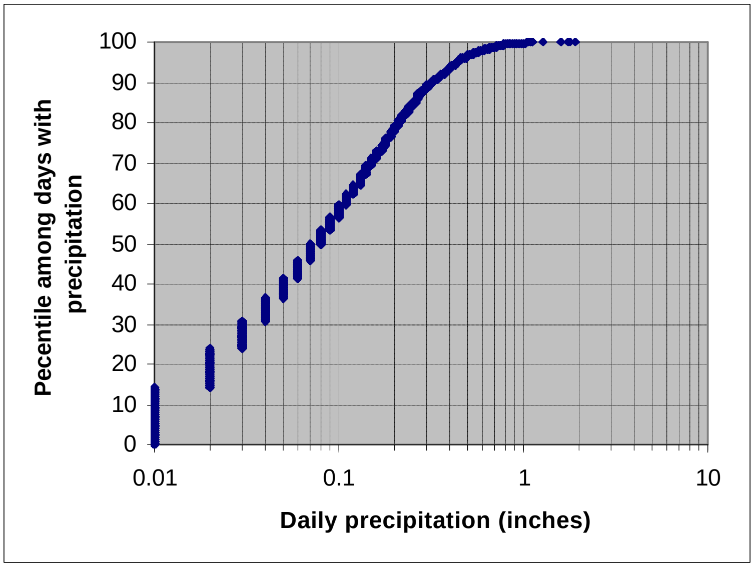

Figure B-1. Cumulative frequency distribution of daily precipitation for days with measurable precipitation at Boise Airport January 1940-November 2001.

Table B-2 and Figure B-2 summarize the persistence of days with precipitation. Of the 90 days per year with precipitation about 24 days each are in episodes with 1 or 2 consecutive days. On average about 15 days per year are in episodes with 3 consecutive days; 10 days are in episodes with 4 consecutive days. The maximum number of consecutive days on record is 16. However, the number of consecutive days with precipitation exceeded 8 days only 12 times in 61 years.

Table B-2. Summary of precipitation persistence (consecutive days).

Consecutive days with precipitation	Number of occurrences (1940-2001)	Total Days	Occurrences per year	Days per year	Cumulative days per year
16	1	16	0.02	0.26	0.26
15	1	15	0.02	0.24	0.50
13	1	13	0.02	0.21	0.71
12	2	24	0.03	0.39	1.10
11	2	22	0.03	0.36	1.45
10	1	10	0.02	0.16	1.62
9	4	36	0.06	0.58	2.20
8	12	96	0.19	1.55	3.75
7	22	154	0.36	2.49	6.24
6	34	204	0.55	3.30	9.53
5	85	425	1.37	6.87	16.40
4	163	652	2.63	10.53	26.93
3	310	930	5.01	15.03	41.96
2	742	1484	11.99	23.98	65.94
1	1474	1474	23.82	23.82	89.76
0	17049	17049	275.47	275.47	365.23

Table B-3 shows information equivalent to Table B-2, except for snowfall days rather than precipitation (rain or snow). For days with snowfall, the snowfall is on average equivalent to approximately 11 times the recorded liquid water equivalent. This equivalence is probably understated since some of the days with recorded snowfall would have had a combination of both rain and snow.

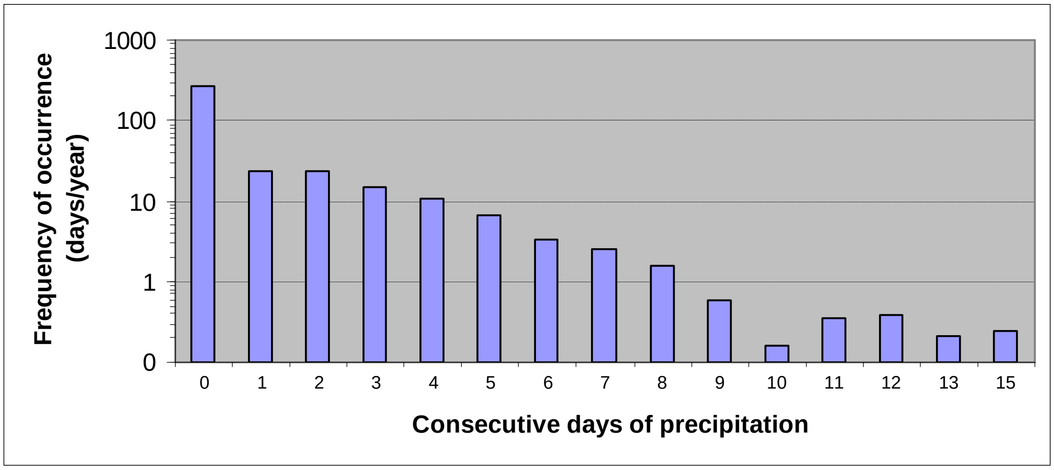

Figure B-2. Histogram of the number of consecutive precipitation days.

Table B-3. Summary of snowfall persistence (consecutive days).

Consecutive days with snow	Number of occurrences (1940-2001)	Total Days	Occurrences per year	Days per year	Cumulative days per year
8	1	8	0.02	0.13	0.13
7	1	7	0.02	0.11	0.24
6	4	24	0.06	0.39	0.63
5	12	60	0.19	0.97	1.60
4	22	88	0.36	1.42	3.02
3	61	183	0.99	2.96	5.98
2	196	392	3.17	6.33	12.31
1	497	497	8.03	8.03	20.34
0	21345	21345	344.89	344.89	365.23

On average, about 20 days per year have measurable snow. Fourteen of those are in episodes with durations of 1 or 2 days. The maximum number of consecutive days with snowfall is 8.

Table B-4 shows a summary of monthly snowfall. December and January have the highest fraction of days with snow, about 20% each and the highest average monthly totals. For days with snowfall, the average amount is oneinch.

Table B-4. Summary of snowfall statistics by month, Boise airport January 1940-October 2001.

Month	Fraction of days with 0.01" or more snowfall	Average daily precipitation when >0	Average monthly snowfall (inches)
Jan	0.21	1.02	6.5
Feb	0.13	0.98	3.6
Mar	0.06	0.83	1.7
Apr	0.02	0.90	0.6
May	0.00	1.55	0.1
Jun	0.00		0.0
Jul	0.00		0.0
Aug	0.00		0.0
Sep	0.00		0.0
Oct	0.00	0.75	0.1
Nov	0.07	1.02	2.2
Dec	0.19	1.06	5.7
Annual	0.06	1.00	20.4

A.1 Wind speed

The cumulative frequency distribution of wind speed is shown in Figure B-3. Winds in the 4-8 mph range were most common, occurring 56% of the time. Calms occurred about 8% of the hours. Sixteen percent exceeded 10 mph and 5% exceeded 14 mph. The maximum recorded wind speed for the period was 30 mph.

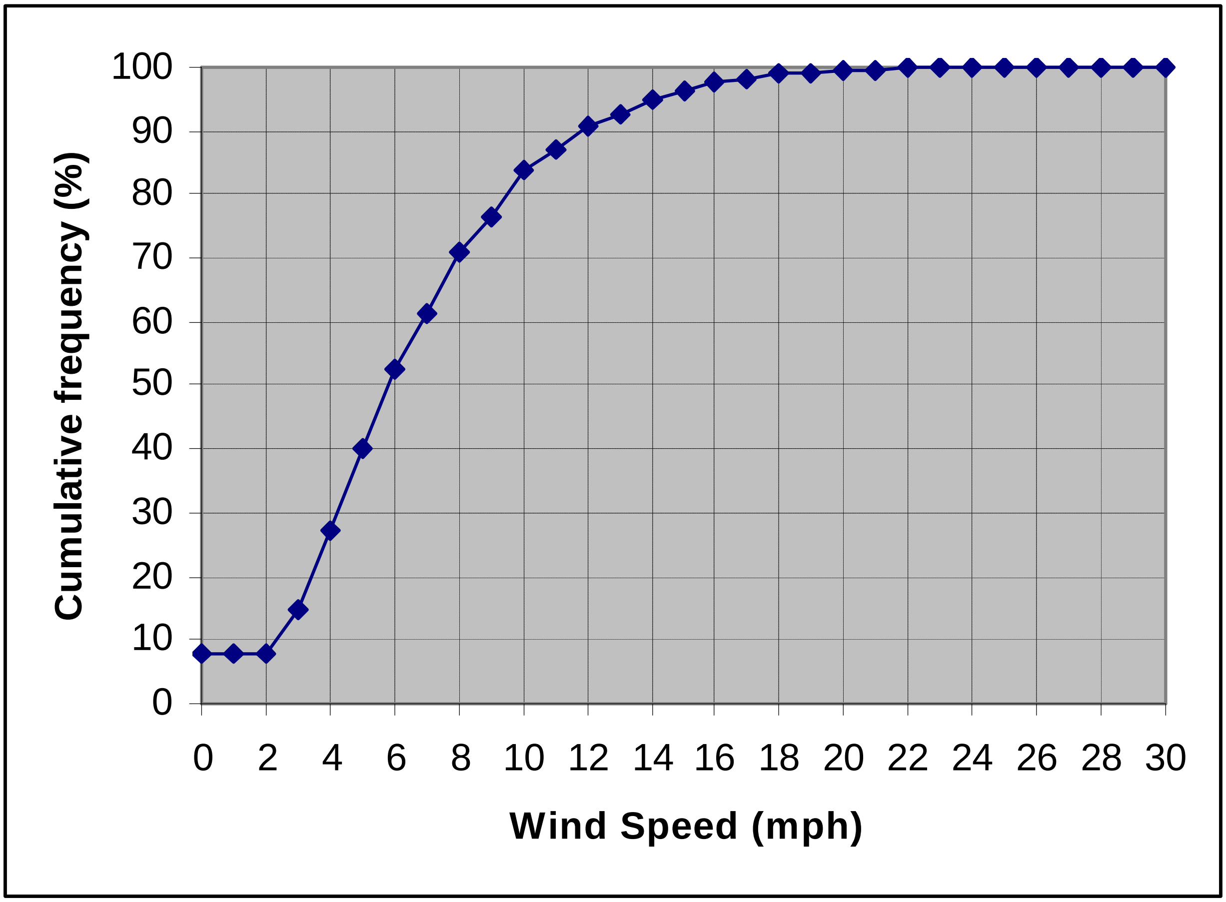

Figure B-3. Cumulative frequency distribution of wind speed (mph).

Average wind speed by month is shown in Figure B-4. Average wind speeds are highest in the spring (March-May) and lowest in December and January.

Average wind speed by time of day (averaged over all months) is shown in Figure B-5. Wind speeds are low from about 9 pm through 8 am. They increase steadily from 8 am to 1 pm and then more slowly to 4 pm. From 5 to 9 pm winds subside steadily. At night, surface-based inversions cause light winds by decoupling the surface air from winds aloft. This results in stable atmospheric conditions overnight. As the mixing layer deepens during the day, higher momentum air is mixed down from aloft, increasing the surface wind speed. Most of the growth in the mixed layer depth and increase in wind speed occurs by early afternoon. Late in the afternoon, the mixed layer depth and surface wind speed increase more slowly. Wind speed decreases later in the day as the inversion sets in. Days are shorter in winter; therefore, compared to the average shown in Figure B-5 wind speeds decrease earlier in the evening and remain calm later into the morning.

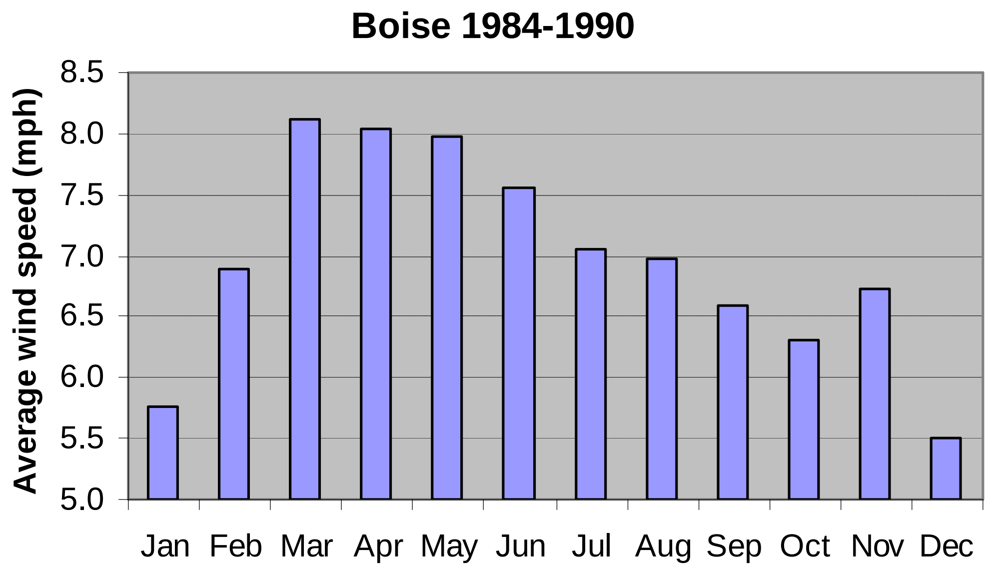

Figure B-4. Average wind speed by month.

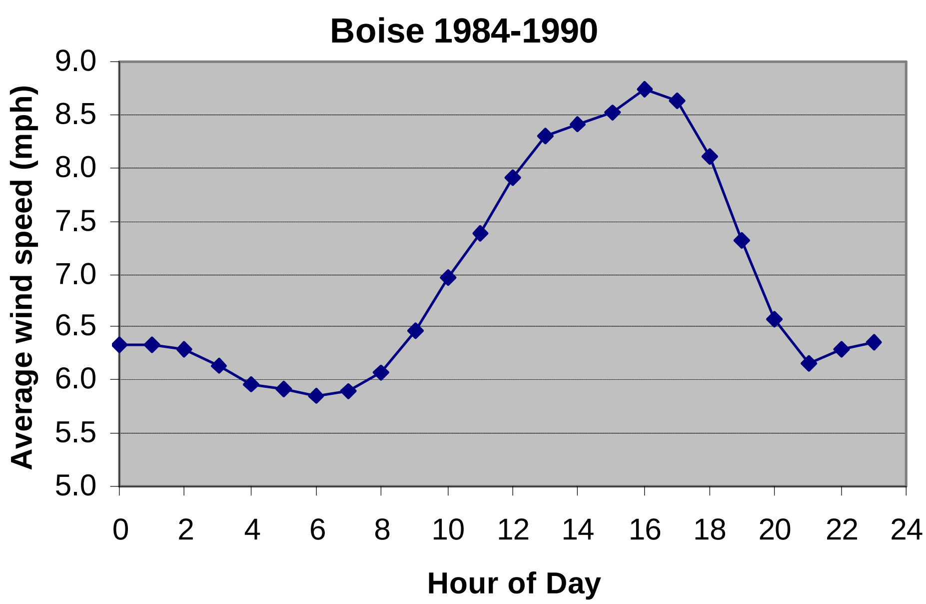

Figure B-5. Average windspeed by time of day.

APPENDIX C : EMISSIONS INVENTORIES: YEARS 2000, 2010, 2015, 2020, AND DECMBER JANUARY 1-9, 1991 AND DECMBER 20-26, 1999

C.1 Treasure valley Road Dust Study Data Files

The road dust emissions calculated as part of the Treasure Valley Road Dust Study (TVRDS) have been appended to the TVRDS final report in electronic format. The files are in Microsoft Excel 200 format and have been split up into three subcategories, each corresponding to a directory. They are: "Emissions_by_TRAKER", "Emissions_By_Silt_Loading", and "Traffic_Demand_Model_Summaries". This appendix describes the contents of the electronic files. Details of the data processing to arrive at these files are presented in the body of the TVRDS report.

C.1.1 Emissions_by_TRAKER

C.1.1.1 File and worksheet list:

a. Dec20-26-1999_emissions_Inventory_By_TRAKER.xls
    i. Dec 20-23 (DS)
    ii. Dec 24 (DS)
    iii. Dec 25-26 (DS)
b. Jan1-9-1991_emissions_Inventory_By_TRAKER.xls
    i. Jan_1-6;8-9 (DS)
    ii. Jan_7 (DS)
c. Year_2000_Emissions_Inventory_By_TRAKER.xls
    i. 2000 (YS)
d. Year_2010_Emissions_Inventory_By_TRAKER.xls
    i. 2010 (YS)
    ii. Jan_1-6;8-9 (DS)
    iii. Jan_7 (DS)
e. Year_2015_Emissions_Inventory_By_TRAKER.xls
    i. 2015 (YS)
    ii. Jan_1-6;8-9 (DS)
    iii. Jan_7 (DS)
f. Year_2020_Emissions_Inventory_By_TRAKER.xls
    i. 2020 (YS)
    ii. Jan_1-6;8-9 (DS)
    iii. Jan_7 (DS)

C.1.1.2 File Contents

These files contain link-level emissions in grams per day for Ada and Canyon Counties. Emissions are based on the TRAKER measurements described in Chapters 4 and 5. Each file contains one or more worksheets with identical formats. There are two types of worksheets: year-specific (YS) worksheets and day-specific (DS) worksheets. The former contains data that apply to the entire year while the latter contain data that apply to specific days. All emissions reported have been corrected for average precipitation conditions as described in Chapter 5. ALL EMISSSIONS ARE REPORTED FOR WEEKEDAYS ONLY. The Subdirectory "Traffic_Demand_Model_Summaries" contains additional information to allow calculation of weekend emissions. The fields in the worksheets along with their descriptions are given below:

C.1.1.2a Field List for worksheets c.i, d.i, e.i, and f.i

FID_1: Feature ID in Traffic Demand Model Database. The feature ID and the projection year together uniquely identify a link in the traffic demand model . for files a. through c., the projection year (PROJ) is 2000. For files d. through f. the projection year is given in the filename (e.g., the projection year for "Year_2015_Emissions_Inventory_By_TRAKER.xls" is 2015).
A: The ID number for the starting Node for the link
B: The ID number for the Terminating Node for the link
COUNTY: The county that the link is in. 1=Ada, 2= Canyon.
Paved AWD PM_{10} : Average winter day PM_{10} paved road dust emissions from the link in Grams per day.
Paved AWD $PM_{2.5}$: Average winter day $PM_{2.5}$ paved road dust emissions from the link in Grams per day.
Paved AAD PM_{10} : Annual average PM_{10} paved road dust emissions from the link in Grams per day
Paved AAD $PM_{2.5}$: Annual average $PM_{2.5}$ paved road dust emissions from the link in Grams per day
Unpaved AWD PM_{10} : Average winter day PM_{10} unpaved road dust emissions from the link in Grams per day.
Unpaved AWD $PM_{2.5}$: Average winter day $PM_{2.5}$ unpaved road dust emissions from the link in Grams per day.
Unpaved AAD PM_{10} : Annual average PM_{10} unpaved road dust emissions from the link in Grams per day
Unpaved AAD $PM_{2.5}$: Annual average $PM_{2.5}$ unpaved road dust emissions from the link in Grams per day

C.1.1.2b Field List for worksheets a.i-iii, b.i-ii, d.ii-iii, e.ii-iii, and f.ii-iii

FID_1: Feature ID in Traffic Demand Model Database. The feature ID and the projectionyear together uniquely identify a link in the traffic demand model . for files a. through c., the projection year (PROJ) is 2000. For files d. through f. the projection year is given in the filename (e.g., the projection year for "Year_2015_Emissions_Inventory_By_TRAKER.xls" is 2015).
A: The ID number for the starting Node for the link
B: The ID number for the Terminating Node for the link
COUNTY: The county that the link is in. 1=Ada, 2= Canyon.
Paved PM_{10} : PM_{10} paved road dust emissions from the link in Grams per day.
Paved $PM_{2.5}$: $PM_{2.5}$ paved road dust emissions from the link in Grams per day.
Unpaved PM_{10} : PM_{10} unpaved road dust emissions from the link in Grams per day
Unpaved $PM_{2.5}$: $PM_{2.5}$ unpaved road dust emissions from the link in Grams per day

C.1.2 Emissions_By_Silt_Loading

C.1.2.1 File and Worksheet List

a. Year_1991_Emissions_Inventory_By_Silt.xls
    i. Emissions_By_Silt_Master_Table
b. Year_2000_Emissions_Inventory_By_Silt.xls
    i. Emissions_By_Silt_Master_Table

c. Year_2010_Emissions_Inventory_By_Silt.xls
    i. Emissions_By_Silt_Master_Table
d. Year_2015_Emissions_Inventory_By_Silt.xls
    i. Emissions_By_Silt_Master_Table
e. Year_2020_Emissions_Inventory_By_Silt.xls
    i. Emissions_By_Silt_Master_Table

C.1.2.2 File Contents

These files contain link-level paved road dust emissions in grams per day of PM_{10} for Ada and Canyon Counties. Emissions have been calculated based on silt loading measurements conducted as part of the TVRDS and silt loadings specified as default values in AP-42. AP-42 does not prescribe a method for correcting paved road dust emissions for precipitation. Therefore, no corrections have been applied to the emissions in these data files. Emissions have been calculated using three different sets of values for silt loadings. "TVRDS1" uses silt loading values measured as part of the TVRDS with the assumption that silt loadings on freeways are equal to the AP-42 default value of 0.02 grams per square meter. "TVRDS2" uses the same values as "TVRDS1" except that the silt loading on freeways is assumed to be the same as for arterials (1.9 and 0.5 grams per square meter for winter and average annual conditions, respectively). "AP-42" simply uses the default values for silt loading for all road classes. ALL EMISSSIONS ARE REPORTED FOR WEEKEDAYS ONLY. The Subdirectory "Traffic_Demand_Model_Summaries" contains additional information to allow calculation of weekend emissions. The fields in the worksheets along with their descriptions are given below:

C.1.2.2a Field list for worksheets a.i, b.i, c.i, and d.i

PROJ: The year corresponding to the Traffic Demand Model projection
FID_1: Feature ID in Traffic Demand Model Database. The feature ID and the projection year together uniquely identify a link in the traffic demand model.
A: The ID number for the starting Node for the link
B: The ID number for the Terminating Node for the link
COUNTY: The county that the link is in. 1=Ada, 2= Canyon.
TVRDS1_W_SL: Silt loading in Grams per square meter used to calculate winter conditions emissions factors as described in Equation 2-3 of the TVRDS report. Silt loadings for freeways are assumed to be equal to the AP-42 default value of 0.02 grams per meter squared.
TVRDS1_Ave_SL: Silt loading in Grams per square meter used to calculate average daily conditions emissions factors as described in Equation 2-3 of the TVRDS report. Silt loadings for freeways are assumed to be equal to the AP-42 default value of 0.02 grams per meter squared.
TRVDS2_W_SL: Silt loading in Grams per square meter used to calculate winter conditions emissions factors as described in Equation 2-3 of the TVRDS report. Silt loadings for freeways are assumed to be equal to those for arterials, 1.9 grams per meter squared.
TVRDS2_Ave_SL: Silt loading in Grams per square meter used to calculate average daily conditions emissions factors as described in Equation 2-3 of the TVRDS report. Silt loadings for freeways are assumed to be equal to those for arterials, 0.5 grams per meter squared.
AP-42_W_SL: Silt loading in Grams per square meter used to calculate winter conditions emissions factors as described in Equation 2-3 of the TVRDS report. These are the default

values specified by AP-42 and do not correspond to any measurements conducted as part of the TVRDS.

AP-42_Ave: Silt loading in Grams per square meter used to calculate average daily conditions emissions factors as described in Equation 2-3 of the TVRDS report. These are the default values specified by AP-42 and do not correspond to any measurements conducted as part of the TVRDS.

TVRDS1_W_E: PM_{10} winter conditions paved road dust emissions in grams per day calculated using TVRDS1 assumptions for silt loading

TVRDS1_Ave_E: PM_{10} average day paved road dust emissions in grams per day calculated using TVRDS1 assumptions for silt loading

TVRDS2_W_E: PM_{10} winter conditions paved road dust emissions in grams per day calculated using TVRDS2 assumptions for silt loading

TVRDS2_Ave_E: PM_{10} average day paved road dust emissions in grams per day calculated using TVRDS2 assumptions for silt loading

AP-42_W_E: PM_{10} winter conditions paved road dust emissions in grams per day calculated using AP-42 assumptions for silt loading

AP-42_Ave_E: PM_{10} average day paved road dust emissions in grams per day calculated using AP-42 assumptions for silt loading

C.1.3 Traffic_Demand_Model_Summaries

C.1.3.1 File and worksheet list:

a. TDM_2000_Summary.xls
    i. TDM_2000_Summary
b. TDM_2010_Summary.xls
    i. TDM_Future_Summary
c. TDM_2015_Summary.xls
    i. TDM_Future_Summary
d. TDM_2020_Summary.xls
    i. TDM_Future_Summary
e. Temporal_Correction_Factors.xls
    i. PM10 Plan Conversions

C.1.3.2 File Contents

Files a. through d. contain the link-level year-specific data for calculating road dust emissions. They contain fields for link speed, length, location, and setting. These four files are derived from the Traffic Demand Model network assembled by COMPASS for the years 2000, 2010, 2015, and 2020. File e. contains traffic volume correction factors to account for weekend/weekday and month to month differences. The data in file e. are needed to calculate emissions for specific days of the year. This file is derived from an Excel spreadsheet created by ENVIRON for calculating temporal variations in road dust emissions.

C.1.3.2a Field list for worksheets a.i, b.i, c.i, and d.i

PROJ: The year corresponding to the Traffic Demand Model projection

FID_1: Feature ID in Traffic Demand Model Database. The feature ID and the projection year together uniquely identify a link in the traffic demand model.

A: The ID number for the starting Node for the link

B: The ID number for the Terminating Node for the link
COUNTY: The county that the link is in. 1=Ada, 2= Canyon.
Urban_rural: Designates whether or not a link is in an urban or rural area. A description of the urban/rural criteria is given in Chapter 4 of the TVRDS
Class: Designates the link as either"Local/Residential", "Collector", " Arterial", or "Freeway"
RD_Speed_meters_per_Second: The posted speed limit on the link.
Link_Length_km: The length of the link in kilometers
V1_1: The average weekday traffic volume on the link.

Appendix G

Settlement Agreement,
Idaho Clean Air Force et al and U.S. EPA

SETTLEMENT AGREEMENT

This Settlement Agreement (the "Agreement") is entered into by and between the Idaho Clean Air Force, an Idaho non-profit association, Erica Peterson, Barbara Gardner, Larry McKinney, the Idaho Conservation League, the Committee for Idaho's High Desert, the Northern Rockies Chapter of the Sierra Club, and the Environmental Defense (formerly Environmental Defense Fund) (collectively, "Petitioners"), the United States Environmental Protection Agency ("EPA"), the Community Planning Association of Southwest Idaho, an Idaho nonprofit association created by joint powers agreement ("COMPASS"), and the Idaho Department of Environmental Quality ("IDEQ"). (EPA and COMPASS are sometimes referred to collectively as "Respondents."):

I. WHEREAS

A. On March 12, 1999, EPA rescinded the applicability of the PM-10 national ambient air quality standards ("NAAQS") and existing non-attainment designation for Northern Ada County, Idaho. 64 Fed. Reg. 12,257 et seq.

B. Petitioners challenged the action before the U. S. Court of Appeals for the Ninth Circuit in *Idaho Clean Air Force et al. v. EPA et al.* Nos. 99-70259 and 70576. COMPASS was granted leave to intervene as a respondent in the litigation.

C. On May 14, 1999, the U.S. Court of Appeals for the District of Columbia Circuit decided *American Trucking Associations et al. v. EPA,* 175 F.3d 1027 (D.C. Cir. 1999), which vacated the new PM-10 standard promulgated by EPA in 1997, the existence of which formed, in part, the basis for rescinding the applicability of the old PM-10 NAAQS to Northern Ada County. Therefore, the Parties agree that EPA must take some action to restore federal particulate matter regulation in Northern Ada County.

D. On June 26, 2000, the EPA Administrator published a notice proposing to reinstate the NAAQS for PM-10 and the nonattainment designation for Northern Ada County, and to repeal 40 C.F.R. §50.6(d). 65 Fed. Reg. 39,321 ("June 26, 2000 proposal"). On December 13, 2000, EPA's Administrator signed a final rule repealing 40 CFR §50.6(d).

E. The purposes of this settlement are:

1. To resolve the litigation before the U.S. Court of Appeals for the Ninth Circuit in *Idaho Clean Air Force et al. v. EPA et al*;

2. To prevent the disruption of transportation planning processes and projects in Northern Ada County while responsible officials prepare and submit to EPA for approval a maintenance plan for PM-10 that includes a motor vehicle emissions budget, and the designated metropolitan planning organization adopts a long range transportation plan and transportation improvement program (“TIP”) that conforms to the maintenance plan, which is required for EPA to redesignate Northern Ada County as attainment for PM-10 in accordance with §§ 107(d)(3)(E) and 175A of the Clean Air Act (“CAA”);

3. To ensure that expected increases in PM-10 emissions from motor vehicles in Northern Ada County are offset by emission reduction measures, including offsets for a certain amount of past emission increases, until a maintenance plan containing motor vehicle emissions budgets is approved by EPA, and a transportation plan and TIP that have been found to conform pursuant to § 176(c) of the Clean Air Act and 40 CFR Part 93 are in effect;

4. To ensure that potential increases in stationary source emissions are subject to permitting rules comparable to those that would apply if the area were designated nonattainment until Northern Ada county is redesignated as attainment pursuant to § 107(d)(3)(E) and a maintenance plan containing motor vehicle emissions budgets is approved by EPA; and

5. To ensure the attainment redesignation request for the Northern Ada County former PM_{10} nonattainment area meets the requirements of CAA §§ 107(d)(3)(E) and 175A.

F. This agreement has been reached by all Parties to the litigation and representatives of IDEQ and the Idaho Attorney General (hereinafter referred to as the “Parties”).

G. IDEQ intends to develop and adopt by 2005 an air shed management plan for the Treasure Valley (Ada and Canyon Counties).

NOW, THEREFORE, all Parties agree

II. <u>General Agreements</u>

A. Dismissal and Reactivation of Pending Litigation.

1. After final approval of this settlement agreement by EPA pursuant to CAA §113(g) as provided in paragraph V.G., Petitioners and Respondents agree to support the issuance of an order by the Ninth Circuit Court of Appeals (the "Court") dismissing the litigation without prejudice to their being reactivated pursuant to the terms of this Agreement, but retaining jurisdiction to reactivate the cases entitled *Idaho Clean Air Force, et al. V. EPA, et al.*, Nos. 99-70259 and 70576 (consolidated) (the "Pending Litigation") upon the occurrence of any of the trigger events set forth in Paragraphs IV.A. or V.B., and to jointly propose the language of such order for consideration by the Court. If the Court enters an order retaining jurisdiction to reactivate the Pending Litigation upon non-performance of the terms of this Agreement, the right of Petitioners and Respondents to reactivate shall extinguish without further action not later than December 31, 2003, if not exercised prior thereto. The Parties consent to entry of an order by the Court retaining jurisdiction to reactivate the Pending Litigation as originally filed in the event that the various obligations undertaken by the Parties and the State of Idaho pursuant to this Agreement are not performed in accordance herewith.

2. If the Court considers the litigation on the merits at any time, then EPA and COMPASS reserve jurisdictional arguments previously asserted in their merits briefs. The Parties agree that in the event this Agreement is not finally executed by the federal government on or before March 31, 2001, or EPA fails to take final action on the June 26, 2000, proposal in accordance with III.A.3., or if any of the actions required by IV.A. or V.B.1.a. or b. of this Agreement are not completed within the time allowed by this Agreement, or any of the events described in V.B.3 occur on or before July 1, 2001, upon motion by Petitioners these cases should be submitted to the Court for decision on the briefs previously filed and the argument had on June 8, 2000. However, each party reserves the right to request that the Court consider any additional arguments or

relevant information at that time and every other party reserves the right to oppose such a request.

B. Rulemaking Activities.

All Parties will, in good faith, work toward (1) the adoption of the rules attached as Attachment A and Attachment B; (2) the inclusion of these rules as revisions to the currently applicable State Implementation Plan (SIP) under Part D of the CAA limiting emissions from major stationary sources and mobile sources during the interim period; and (3) the development and submission to EPA of a request for approval of a maintenance plan containing motor vehicle emissions budgets for PM-10 and a request for redesignation of Northern Ada County as attainment.

III. <u>Dismissal of Litigation Subject to Reactivation:</u>

A. In the event the Court enters the order described in Paragraph II.A. 1.:

1. Petitioners' right to reactivate the Pending Litigation shall terminate if EPA takes final action on its June 26, 2000, proposal to reinstate the NAAQS for PM-10 and the nonattainment designation for Northern Ada County consistent with the expectations identified in paragraph V. D.

2. Petitioners' right to reactivate the Pending Litigation shall terminate in the event (a) Northern Ada County is redesignated attainment for particulate matter; (b) EPA approves a maintenance plan consistent with the final Agency action contemplated under the terms of this paragraph that contains a motor vehicle emissions budget for PM-10 and that meets all of the requirements of CAA § 175A including but not limited to, contingency provisions; and (c) a transportation plan and TIP are adopted pursuant to this agreement and are found to conform pursuant to CAA § 176(c) and 40 CFR part 93. EPA anticipates that any final rulemaking action approving a request to redesignate Northern Ada County as attainment would necessarily entail taking actions simultaneously to restore the PM-10 standards described in 40 CFR §50.6 that formerly applied to that area, and to reinstate the nonattainment status of Northern Ada County consistent with the terms of CAA § 107(d)(4)(B), as a condition precedent of such redesignation to attainment. Recognizing that EPA cannot legally bind itself to

the content of a final rule, Petitioners agree that any such final rule approving a request to redesignate Northern Ada County as attainment in the manner and under the conditions described above would render the pending litigation moot if the portion of EPA's action restoring the PM-10 standards described in 40 CFR § 50.6 that formerly applied to the area and reinstating the nonattainment status of Northern Ada County consistent with the terms of CAA § 107(d)(4)(B) becomes final. If EPA takes such final rulemaking action rendering the claims in the pending litigation moot, Petitioners' right to reactivate the Pending Litigation shall terminate. Neither such termination, nor anything else in this Settlement Agreement, shall preclude Petitioners' right, which is expressly reserved, to file a new lawsuit challenging the adequacy of EPA's actions under clause (a) and/or (b) of this paragraph, provided Petitioners seek timely judicial review of such redesignation and/or plan approval.

3. Petitioners may ask the Court to reactivate the litigation, and the Parties agree that they will not oppose a motion requesting reactivation of the litigation, in the event that:

a. EPA receives information demonstrating that one or more events triggering EPA's obligation to take final action on its proposal to promulgate a final reinstatement of the NAAQS and nonattainment designation for PM-10 has occurred as set forth in paragraphs V. B, or EPA fails to take one of the actions required in paragraph V., and either b. or c. occurs;

b. EPA fails to sign and forward to the Federal Register for publication within sixty (60) days of receipt of the information or the completion date for an action described in section III.A.3.a; or

c. The final rule promulgated by EPA fails to reinstate the NAAQS and nonattainment designation for PM-10 effective thirty (30) days following publication in the Federal Register as anticipated under V.D. of this Agreement.

B. This Agreement shall not take effect unless the Court enters an order consistent with the provisions of Paragraph II.A.1. retaining its jurisdiction consistent with the terms of this Agreement. The Parties agree to work in good faith to obtain such order.

IV. IDEQ Actions:

A. IDEQ will submit to EPA as revisions to the State Implementation Plan rules on stationary and mobile source emissions not later than ten days following adoption of the rules by the Board of Environmental Quality, but in no event later than March 1, 2001. The Parties agree to work, in good faith, to obtain such adoption by the Board on or before January 31, 2001. Such rules shall not be materially changed in substance from the draft rules attached hereto as Attachments A (New Source Review of Major Stationary Sources) and B (Program to Limit Increases in Emissions of Particulate Matter less than 10 microns in size from Mobile Sources), unless modifications to the attached draft rules are agreed to in writing by each party, or the change is circulated to the Parties to this Agreement by e-mail and overnight delivery, and no objection is made by any party within seven (7) days following receipt thereof. If objections are made by any party that a proposed change is material to the meaning or intent of the rule and not acceptable, the Parties agree to discuss the proposed change within five (5) days. If agreement is not reached regarding mutually acceptable changes to the rule, a final rule adopting such change shall not satisfy the requirements of this paragraph. The Parties expressly recognize that IDEQ is obligated to review and respond to public comment. Such rules shall be adopted as pending rules pursuant to Idaho Code Section 67-5224 and shall be submitted to the Idaho legislature for its consideration and approval pursuant to Idaho Code Section 39-118B and Title 67, Chapter 52. By operation of law, the rules will become effective and final upon the adjournment *sine die* of the 2001 Idaho legislature unless rejected by the legislature. IDEQ shall give notice of adjournment to EPA Region 10 within three (3) working days following adjournment *sine die*.

B. IDEQ will complete and submit to EPA no later than September 30, 2002, a maintenance demonstration and plan containing motor vehicle emissions budgets for Northern Ada County and other measures necessary to meet the requirements of CAA § 175A as part of an application for redesignation of the former nonattainment area to attainment under § 107(d)(3)(E) of the Clean Air Act.

C. All Parties recognize that various State governing bodies including the legislature must act or have an opportunity to act upon such rules and plans before they become final or legally effective and that the representatives of IDEQ cannot bind the State of Idaho with regard to the final outcome before such bodies. If material changes (as defined in paragraph IV.A.) are made to such rules, or such rules are suspended or rendered ineffective by administrative, legislative or judicial action at any time prior to the completion of the events described in III.A. 1. or 2. hereof without the consent of the Parties, such rules shall not be deemed consistent with the undertaking by the State set forth in this agreement to promulgate final rules or to submit a SIP revision to EPA for approval.

D. The parties agree and acknowledge that, pursuant to the CAA, EPA must approve or disapprove any proposed revisions to the State Implementation Plan through notice and comment rulemaking procedures. Nothing in this Agreement shall be read to suggest that EPA has pre-approved any such revisions that may be proposed by IDEQ. In addition, the above-described procedures for resolving objections to amendments to Attachments A and B to this Agreement shall have no effect whatsoever on EPA's authority to approve or disapprove any proposed State Implementation Plan revisions that are submitted to it under this Agreement.

V. <u>EPA Actions:</u>

A. EPA will withhold final action on the June 26, 2000, proposed reinstatement of the PM-10 NAAQS and nonattainment designation for Northern Ada County in order to provide an opportunity for (1) Idaho to adopt and submit to EPA within ten (10) days following final adoption by the Idaho Board of Environmental Quality, but in no event later than March 1, 2001, a revision to the currently applicable Idaho State Implementation Plan under Part D, Title I of the CAA consisting of rules on stationary and mobile source emissions not materially changed (as defined in Paragraph IV.A.) from the proposed rules contained in Attachment A and Attachment B hereof , (2) Idaho to complete and submit to EPA no later than September 30, 2002, a maintenance demonstration and plan for PM-10 containing motor vehicle emissions budgets and other requirements (including contingency provisions) in accordance with § 175A of the Clean Air Act and a request to redesignate the area to attainment, and (3) EPA to take final action on all elements of the submitted maintenance plan and requirements and a request for redesignation of Northern Ada County to attainment for PM-10 no later than September 30, 2003.

B. 1. EPA shall take final agency action on the portion of the June 26, 2000, notice of proposed rulemaking that would reinstate the PM-10 standard and the nonattainment designation for Northern Ada County in accordance with the provisions of paragraph V.D. following the deadline specified for each event listed below, unless the actions specified in each of the following subparagraphs has occurred by the specified date:

a. IDEQ submits the rules specified in Paragraph IV.A. to EPA for approval of the revision to the Idaho State Implementation Plan consistent with the provisions of paragraph IV.A..

b. A notice of final rulemaking that approves the revisions to the Idaho State Implementation Plan described in paragraph IV.A. is signed by the authorized official of EPA and forwarded to the Federal Register for publication within one hundred twenty (120) days after submission of the SIP revision by Idaho, provided however, that EPA may, if necessary, delay such action until thirty (30) days have elapsed following adjournment *sine die* of the 2001 Idaho Legislature.

c. IDEQ submits to EPA a maintenance demonstration and plan in compliance with Paragraph IV.B.

2. No later than September 30, 2003, an authorized official of EPA shall sign a notice of final rulemaking and forward it to the Office of the Federal Register for publication, either—

(a) restoring the PM-10 standards described in 40 CFR § 50.6 that formerly applied to the area and reinstating the nonattainment status of Northern Ada County consistent with the terms of CAA § 107(d)(4)(B) as a precondition to approving the maintenance plan for Northern Ada County, approving such maintenance plan, and granting a request for designation of the former nonattainment area to attainment in accordance with § 107(d)(3)(E) of the Clean Air Act, or

(b) taking final action on the proposed June 26, 2000, reinstatement of the NAAQS for PM-10.

3. In addition to the above dates for taking final action on the June 26, 2000, rulemaking proposal, and notwithstanding full compliance with the obligations in V.B.1.of this Agreement,

unless EPA has taken final action approving the request for redesignation to attainment, EPA agrees to take final action on its proposal to reinstate the PM-10 NAAQS and nonattainment designation for Northern Ada County within sixty (60) days after --

a. any quarterly AIRS data submittal under 40 CFR § 58.35, in which a violation of the NAAQS for PM-10 [40 CFR § 50.6] (as if the PM-10 NAAQS were in effect in Northern Ada County) is reported; or

b. any administrative, legislative or judicial decision or other action that repeals, suspends or otherwise renders ineffective either of the rules required by paragraph IV.A. to be adopted and submitted by Idaho as a revision to the State Implementation Plan.

C. Any time period for actions required pursuant to V.B. may not be extended except by written agreement of the Parties.

D. Whenever EPA is required to take a final action on its June 26, 2000 proposal under the terms of this Agreement, EPA shall sign and submit such notice to the Federal Register for publication no later than sixty (60) days following the event giving rise to EPA's obligation. Although EPA cannot legally bind itself to the content of a final rule, the Parties acknowledge that this Agreement is predicated on the expectation that any such final rule will reinstate the NAAQS for PM-10 under CAA § 109 and the nonattainment designation for PM-10 pursuant to CAA § 107(d) effective no later than thirty (30) days following publication of the final rule in the Federal Register.

E. EPA intends to provide:

1. FY 2000/2001 funds in the amount of $25,000 towards a public education campaign to inform employers and the general public in the Treasure Valley about the Commuter Choice program, particularly its tax and air quality benefits.

2. FY 2000/ 2001 funds in the amount of $75,000 to EPA Region X for funding technical assistance to Petitioners to resolve technical issues raised by the Parties related to monitoring air quality, determining meteorological conditions affecting the dispersal of air pollutants, and estimating emissions and the benefits of control measures.

3. FY 2000 /2001 funds in the amount of $50,000 to retrofit high polluting diesel engines on fleet vehicles operated exclusively or primarily in the Northern Ada County area.

4. In the event that EPA fails to provide these funds there will be no consequences under this Agreement.

F. Petitioners' Petitions for Review include claims for costs of litigation, including reasonable attorneys' fees, under section 307 of the Clean Air Act. If the Court grants the Parties' request to dismiss these cases while retaining jurisdiction to reactivate the same cases upon the occurrence of any of the trigger events set forth in Paragraphs IV.A or B, or V.B., then, without admitting any question of fact or law on this issue, Petitioners and the United States agree to settle all of the Petitioners' claims for costs of litigation, including attorneys' fees, for a grand total of $139,119.15. This amount will represent a full settlement of Petitioners' claims for costs of litigation, including reasonable attorneys' fees, as of the time the court enters the order dismissing the cases as contemplated under the terms of this agreement. Petitioners shall not waive any claim for costs of litigation, including reasonable attorneys' fees, for efforts required to monitor and enforce implementation of this Agreement after dismissal by the Court. The United States reserves its right to oppose any future claim or award of costs of litigation, including attorneys' fees, as well as the amount of any such claim or award.

G. The parties agree and acknowledge that before this proposed Agreement can be finalized, EPA must provide notice in the Federal Register and an opportunity for comment pursuant to Clean Air Act § 113(g), 42 U.S.C. §7413(g). EPA will expeditiously prepare such notice and forward it to the Office of Federal Register within ten (10) days of lodging the proposed Agreement with the Court. After this proposed Agreement has undergone an opportunity for notice and comment, the Administrator and/or Attorney General, as appropriate, shall promptly consider any written comments received in determining whether to withdraw or withhold consent to this proposed Agreement, in accordance with section 113(g) of the Clean Air Act. If the federal government elects not to withdraw or withhold consent to this Agreement, the federal government shall promptly notify the Office of the Circuit Mediator and the Parties that the Agreement is a final settlement agreement. If the federal government elects to withdraw or withhold consent to the proposed Agreement, then EPA shall promptly notify the Office of the Circuit Mediator and the Parties of this fact. In that instance, the Parties agree that they will discuss whether the proposed Agreement can be amended in a manner that will allow the federal government to provide its consent to the proposed Agreement. If no agreement regarding any necessary amendments is reached within thirty (30) days, or if the federal government has not finally executed this Agreement by March 31, 2001, then any party may request that the Court take these cases under submission.

VI. COMPASS Obligations:

A. During the period of this Agreement and until EPA's approval of a maintenance plan and redesignation of Northern Ada County to attainment, COMPASS agrees to implement, or obtain necessary commitments to implement, control measures to comply with Attachment B. The first treatment of dust suppressant for FY 2000 emissions offsets to be achieved by dust suppression pursuant to the mobile source rule (Attachment B) shall be applied prior to December 31, 2000.

B. COMPASS agrees to implement a diesel engine retrofit program pursuant to paragraph V.E.3. upon receipt of funding.

Dated: ___________

By:______________________________

Robert Yuhnke

Attorney for Idaho Clean Air Force, Erica Peterson, Barbara Gardner, Larry McKinney, Idaho Conservation League, Committee for Idaho's High Desert, Northern Rockies Chapter of the Sierra Club and Environmental Defense

Dated:_____________

By:______________________________

Victoria Patton

Attorney for Environmental Defense

Dated:______________ By:________________________________

David A. Carson

United States Department of Justice

Attorney for the United States Environmental Protection Agency

Dated: _______________ By:________________________________

Kenneth R. McClure

Givens Pursley LLP

Attorney for the Community Planning Association of Southwest Idaho, an Idaho nonprofit association created by joint powers agreement

Dated:_______________ By:________________________________

Lisa Kronberg

Idaho Deputy Attorney General

Attorney for the Idaho Department of Environmental Quality

ATTACHMENT A

Stationary Source Rule

204. PERMIT REQUIREMENTS FOR NEW MAJOR FACILITIES OR MAJOR MODIFICATIONS IN NONATTAINMENT AREAS AND IN THE FORMER PM-10 NORTHERN ADA COUNTY NONATTAINMENT AREA (AS DEFINED IN SECTION 582). The provision specifically referencing the former PM-10 northern Ada County nonattainment area in Section 204 shall expire by its terms and without further action when the EPA designates the former nonattainment area as either attainment or nonattainment. No permit to construct shall be granted for a new major facility or major modification which is proposed for location in a nonattainment area or in the former PM-10 northern Ada County nonattainment area and which would be major for the nonattainment regulated air pollutant(s) unless the applicant shows to the satisfaction of the Department all of the following: ( )

01. LAER. The new major facility or major modification would be operated at the lowest achievable emission rate (LAER) for the nonattainment regulated air pollutant, specifically: (4-5-00)

a. A new major facility would meet the lowest achievable emission rate at each new emissions unit which emits the nonattainment regulated air pollutant; and (4-5-00)

b. A major modification would meet the lowest achievable emission rate at each new or modified emissions unit which has a net emissions increase of the nonattainment regulated air pollutant. (4-5-00)

02. Required Offsets. Allowable emissions from the new major facility or major modification are offset by reductions in actual emissions from stationary sources, facilities, and/or mobile sources in the nonattainment area so as to represent reasonable further progress. All offsetting emission reductions must satisfy the requirements for emission reduction credits (Section 460) and provide for a net air quality benefit which satisfies the requirements of Section 208. If the offsets are provided by other stationary sources or facilities, a permit to construct shall not be issued for the new major facility or major modification until the offsetting reductions are made enforceable through the issuance of operating permits. The new major facility or major modification may not commence operation, and an operating permit for the new major facility or major modification shall not be effective before the date the offsetting reductions are achieved.(4-5-00)

03. Compliance Status. All other sources in the State owned or operated by the applicant, or by any entity controlling, controlled by or under common control with such person, are in compliance with all applicable emission limitations and standards or subject to an enforceable compliance schedule. (5-1-94)

04. Effect On Visibility. The effect on visibility of any federal Class I area, Class

I area designated by the Department, or integral vista of a mandatory federal Class I area, by the new major facility or major modification is consistent with making reasonable progress toward remedying existing and preventing future visibility impairment, except that: (5-1-94)

a. New major facilities, or major modifications to major facilities, which are not designated facilities and which do not emit or have the potential to emit two-hundred fifty (250) tons per year, or more, of any regulated air pollutant are exempt. (4-5-00)

b. Any integral vista which the Federal Land Manager has not identified at least six (6) months prior to the submittal of a complete application, or which the Department determines was not identified in accordance with the criteria adopted pursuant to 40 CFR Part 51.304(a), may be exempted by the Department. (5-1-94)

05. Definition of "Nonattainment Regulated Air Pollutant(s)." For the purposes of Section 204, the term "nonattainment regulated air pollutant(s)" shall be defined to include the pollutant PM-10 in the former northern Ada County nonattainment area. ( )

ATTACHMENT B

Mobile Source Emissions Rule

582. INTERIM CONFORMITY PROVISIONS FOR NORTHERN ADA COUNTY FORMER NONATTAINMENT AREA FOR PM-10.

The purpose of Section 582 is to implement part of the settlement of "Idaho Clean Air Force, et al. v. EPA, et al." Section 582 requires that the growth in transportation related PM-10 emissions be offset annually in the absence of federal transportation conformity requirements in the former PM-10 nonattainment area in northern Ada County, Idaho. Section 582 will remain in place until a PM-10 maintenance demonstration and maintenance plan containing a motor vehicle emissions budget can be developed, submitted to the U.S. Environmental Protection Agency (EPA) and approved as meeting the requirements of § 175A of the Clean Air Act, and the transportation plan and TIP for northern ADA County has been found to conform to the applicable implementation plan. The Department will prepare a PM-10 maintenance plan within the agreed upon time frame to be submitted to EPA for approval. ( )

01. Definitions. Terms not specifically defined in Subsection 582.01 are defined in Sections 565 and 566 of these rules. ( )

a. Annual Reduction Amount. Represents the estimated, annual average increase in PM-10 emissions in the former nonattainment area expected between the years 1997 and 2005 and is calculated at seven hundred fifty (750) kg/day. ( )

c. Settlement Agreement. The settlement agreement approved by the Ninth Circuit Court of Appeals to resolve "Idaho Clean Air Force, et al. v. EPA, et al.," (Ninth Circuit Docket Nos. 99-70289 & 99-70576). ( )

d. Emissions Reductions. Reductions in emissions of PM-10 or PM-10 precursors to be achieved by transportation control measures (as defined in 40 CFR 93.101) or other binding emissions control measures. Control measures adopted by the Metropolitan Planning Organization and approved by the Department shall be enforceable obligations of the State Implementation Plan (SIP). ( )

e. Former Nonattainment Area. That portion of northern Ada County designated as a nonattainment area for PM-10 by 40 CFR 81.87 prior to March 12, 1999. ( )

f. Interim Period. The period beginning with the fiscal year commencing October 1, 2000, until EPA approves a maintenance plan containing a motor vehicle emission budget for the former nonattainment area and the Metropolitan Planning Organization adopts a transportation plan and TIP that is found to conform in accordance with § 176(c) of the Clean Air Act and 40 CFR Part 93. ( )

g. Metropolitan Planning Organization (MPO). For purposes of Section 582, Community Planning Association of Southwest Idaho (COMPASS), or its successor organization, is the MPO for the former nonattainment area. ( )

h. Regionally Significant Project. A transportation project, other than an exempt project, that is on a facility which serves regional transportation needs (such as access to and from the area outside the region, major activity centers in the region, major planned developments such as new retail malls, sports complexes, etc., or transportation terminals as well as most terminals themselves) and would normally be included in the modeling of a metropolitan area's transportation network, including, at a minimum: ( )

i. All principal arterial highways; ( )

ii. All fixed guideway transit facilities that offer an alternative to regional highway travel; and ( )

iii. Any other facilities determined to be regionally significant through Section 570, interagency consultation. ( )

02. Applicability. The provisions of Section 582 shall apply during the interim period. The transportation conformity requirements of 40 CFR Part 93 applicable to nonattainment areas shall apply to the former nonattainment area pursuant to 42 U.S.C. § 7506(c)(5) if the area is designated nonattainment or attainment with an approved maintenance plan. The provisions of Section 582 shall no longer apply after a maintenance demonstration and maintenance plan containing motor vehicle emissions budget(s) for PM-10 is submitted by the Department as a State Implementation Plan (SIP) revision, has been approved by EPA as meeting the requirements of § 175A of the Clean Air Act, and a transportation plan and TIP have been found to conform to the applicable implementation plan pursuant to 40 CFR Part 93. ( )

03. Adoption of Control Measures and Demonstration of Emissions Reductions. As a precondition to: ( )

a. The expenditure of any non-exempt federal transportation funds that would be prohibited under a conformity lapse, ( )

b. The construction of any regionally significant projects that would be prohibited under a conformity lapse, ( )

c. The execution by the Idaho Transportation Department or the Ada County Highway District of any project agreements required by 23 U.S.C. § 106(a) that would be prohibited under a conformity lapse, or ( )

d. The execution of agreements with contractors to begin construction on a highway project that is not exempt from a conformity determination pursuant to 40 CFR 93.126 and 93.127 during any fiscal year during the interim period, the MPO shall: ( )

i. Demonstrate that the control measures adopted to achieve emissions reductions in prior fiscal years have been implemented and will continue to be implemented during the next fiscal year, ( )

ii. Demonstrate that the control measures adopted to achieve emissions reductions have achieved the magnitude of emissions reductions expected as a result of the implementation of such measures, ( )

iii. Adopt (subject to approval by the Department pursuant to Section 852.04) control measures adequate to achieve emissions reductions reasonably calculated to reduce actual emissions during the next fiscal year in the former nonattainment area by the annual reduction amount, at a minimum, in addition to any emissions reductions required to be achieved prior to the beginning of such fiscal year, and ( )

iv. With regard to control measures that will not be implemented directly by the MPO, obtain written commitments from the responsible entities that the control measures will be implemented in the manner and within the fiscal year required to meet the emission reductions. ( )

04. Department Review. Following adoption by the MPO, the control measures designed to achieve the new emissions reductions for the next fiscal year, associated emissions calculations, and the demonstrations required by Subsection 582.03 shall be submitted to the Department no later than April 1 of each year. The Department shall review and approve the submission if the Department determines that the requirements of Subsection 582.03 are met in accordance with the following.: ( )

i. The Department will respond to the submittal within thirty (30) days of receipt. The response may include approval of the submission, a request for further information, or conditional approval of the control measures subject to submission of evidence that entities responsible for implementation of the measures have adopted any ordinances, appropriations or other approvals needed to complete the implementation of such measures. If further information is required, such information shall be submitted to the Department within thirty (30) days of request. The Department shall take final action to approve or deny the submission within ninety (90) days of the MPO's submission of the documentation required by Subsection 582.03; and ( )

ii. The Department shall by July 1 of each year during the interim period provide to the MPO, the Ada County Highway District Commissioners and the Idaho Department of Transportation a report listing the emissions control measures implemented and the emissions control measures planned but not yet implemented for the then-current fiscal year, together with the Department's written determination as to whether the Emissions Reductions associated with such emissions control measures satisfy the requirements under Section 582. ( )

05. First Year Emissions Reductions. For the initial fiscal year to which Section 582 applies, the MPO shall adopt new control measures reasonably calculated to achieve emissions reductions of two thousand (2000) kg/day. The MPO may take credit for any reductions in transportation-related emissions of PM-10 that were actually achieved by the implementation of enforceable control measures or other measures following March 12, 1999, and that continue to be implemented during the interim period. ( )

06. Restrictions if Emissions Reductions Not Adopted. If the MPO adopts control measures for the purpose of achieving emissions reductions in a fiscal year, and the relevant local governmental entities do not adopt the necessary implementing ordinances or appropriate necessary funds, if any, by the beginning of the following fiscal year, the MPO shall not expend any non-exempt federal transportation funds or construct any regionally significant projects, that would be prohibited under a conformity lapse, in such following fiscal year until each of the relevant local governmental entities, if any, take such actions as may be necessary to implement the control measures previously approved by the MPO and the Department. ( )

07. Restrictions on TIP if Emissions Reductions Not Adopted or Achieved. If: ( )

a. Control measures required to achieve emissions reductions for a prior fiscal year have not been implemented, or ( )

b. The Department does not approve the control measures submitted by the MPO as adequate to achieve the required emissions reductions for any fiscal year, then: ( )

i. The MPO shall not submit any TIP or TIP revision for a project subject to the requirements of Subsection 582.03, that would be prohibited under a conformity lapse, to the Idaho Transportation Department for inclusion into the State Transportation Improvement Program or to FHWA/FTA for approval, and ( )

ii. No new agreement for a project subject to the requirements of Subsection 582.03, that would be prohibited under a conformity lapse, may be executed by the Idaho Transportation Department or the Ada County Highway District until control measures adequate to achieve the total emissions reductions required for any prior fiscal year are implemented and the control measures adequate to achieve the total emissions reductions for the next fiscal year are approved. ( )

Appendix H

John Calcagni memo of September 4, 1992 on
Procedures for Processing Request to Redesignate Areas to Attainment.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

4 SEP 1992

MEMORANDUM

SUBJECT: Procedures for Processing Requests to Redesignate Areas to Attainment

FROM: John Calcagni, Director
Air Quality Management Division (MD-15)

TO: Director, Air, Pesticides and Toxics Management Division, Regions I and IV
Director, Air and Waste Management Division, Region II
Director, Air, Radiation and Toxics Division, Region III
Director, Air and Radiation Division, Region V
Director, Air, Pesticides and Toxics Division, Region VI
Director, Air and Toxics Division, Regions VII, VIII, IX, and X

Purpose

The Office of Air Quality Planning and Standards (OAQPS) expects that a number of redesignation requests will be submitted in the near future. Thus, Regions will need to have guidance on the applicable procedures for handling these requests, including maintenance plan provisions. This memorandum, therefore, consolidates the Environmental Protection Agency's (EPA's) guidance regarding the processing of requests for redesignation of nonattainment areas to attainment for ozone (O_3), carbon monoxide (CO), particulate matter (PM-10), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and lead (Pb). Regions should use this guidance as a general framework for drafting Federal Register notices pertaining to redesignation requests. Special concerns for areas seeking redesignation from unclassifiable to attainment will be addressed on a case-by-case basis.

Background

Section 107(d)(3)(E) of the Clean Air Act, as amended, states that an area can be redesignated to attainment if the following conditions are met:

1. The EPA has determined that the national ambient air quality standards (NAAQS) have been attained.

2. The applicable implementation plan has been fully approved by EPA under section 110(k).

3. The EPA has determined that the improvement in air quality is due to permanent and enforceable reductions in emissions.

4. The State has met all applicable requirements for the area under section 110 and Part D.

5. The EPA has fully approved a maintenance plan, including a contingency plan, for the area under section 175A.

Each of these criteria is discussed in more detail in the following paragraphs. Particular attention is given to maintenance plan provisions at the end of this document since maintenance plans constitute a new requirement under the amended Clean Air Act. Exceptions to the guidance will be considered on a case-by-case basis.

1. Attainment of the Standard

The State must show that the area is attaining the applicable NAAQS. There are two components involved in making this demonstration which should be considered interdependently. The first component relies upon ambient air quality data. The data that are used to demonstrate attainment should be the product of ambient monitoring that is representative of the area of highest concentration. These monitors should remain at the same location for the duration of the monitoring period required for demonstrating attainment. The data should be collected and quality-assured in accordance with 40 CFR 58 and recorded in the Aerometric Information Retrieval System (AIRS) in order for it to be available to the public for review. For purposes of redesignation, the Regional Office should verify that the integrity of the air quality monitoring network has been preserved.

For PM-10, an area may be considered attaining the NAAQS if the number of expected exceedances per year, according to 40 CFR 50.6, is less than or equal to 1.0. For O_3, the area must show that the average annual number of expected exceedances, according to 40 CFR 50.9, is less than or equal to 1.0 based on data from all monitoring sites in the area or its affected downwind environs. In making this showing, both PM-10 and O_3 must rely on 3 complete, consecutive calendar years of quality-assured air quality monitoring data, collected in accordance with 40 CFR 50, Appendices H and K. For CO, an area may be considered attaining the NAAQS if there are no violations, as determined in accordance with 40 CFR 50.8, based on 2 complete, consecutive calendar years of quality-assured monitoring data. For SO_2, according to 40 CFR 50.4, an area must show no more than one exceedance annually and for Pb, according to section 50.12, an area may show no exceedances on a quarterly basis.

The second component relies upon supplemental EPA-approved air quality modeling. No such supplemental modeling is required for O_3 nonattainment areas seeking redesignation. Modeling may be necessary to determine the representativeness of the monitored data. For pollutants such as SO_2 and CO, a small number of monitors typically is not representative of areawide air quality or areas of highest concentration. When dealing with SO_2, Pb, PM-10 (except for a limited number of initial moderate nonattainment areas), and CO (except moderate areas with design values of 12.7 parts per million or lower at the time of passage of the Clean Air Act Amendments of 1990), dispersion modeling will generally be necessary to evaluate comprehensively sources' impacts and to determine the areas of expected high concentrations based upon current conditions. Areas which were designated nonattainment based on modeling will generally not be redesignated to attainment unless an acceptable modeling analysis indicates attainment. Regions should consult with OAQPS for further guidance addressing the need for modeling in specific circumstances.

2. State Implementation Plan (SIP) Approval

The SIP for the area must be fully approved under section 110(k),[1] and must satisfy all requirements that apply to the area. It should be noted that approval action on SIP elements and the redesignation request may occur simultaneously. An area cannot be redesignated if a required element of its plan is the subject of a disapproval; a finding of failure to submit or to implement the SIP; or partial, conditional, or limited approval. However, this does not mean that earlier issues with regard to the SIP will be reopened. Regions should not reconsider those things that have already been approved and for which the Clean Air Act Amendments did not alter what is required. In contrast, to the extent the Amendments add a requirement or alter an existing requirement so that it adds something more, Regions should consider those issues. In addition, requests from areas known to be affected by dispersion techniques which are inconsistent with EPA guidance will continue to be considered unapprovable under section 110 and will not qualify for redesignation.

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[1]Section 110(k) contains the requirements for EPA action on plan submissions. It addresses completeness, deadlines, full and partial approval, conditional approval, and disapproval.

3. Permanent and Enforceable Improvement in Air Quality

The State must be able to reasonably attribute the improvement in air quality to emission reductions which are permanent and enforceable.[2] Attainment resulting from temporary reductions in emission rates (e.g., reduced production or shutdown due to temporary adverse economic conditions) or unusually favorable meteorology would not qualify as an air quality improvement due to permanent and enforceable emission reductions.

In making this showing, the State should estimate the percent reduction (from the year that was used to determine the design value for designation and classification) achieved from Federal measures such as the Federal Motor Vehicle Control Program and fuel volatility rules as well as control measures that have been adopted and implemented by the State. This estimate should consider emission rates, production capacities, and other related information to clearly show that the air quality improvements are the result of implemented controls. The analysis should assume that sources are operating at permitted levels (or historic peak levels) unless evidence is presented that such an assumption is unrealistic.

4. Section 110 and Part D Requirements

For the purposes of redesignation, a State must meet all requirements of section 110 and Part D that were applicable prior to submittal of the complete redesignation request. When evaluating a redesignation request, Regions should not consider whether the State has met requirements that come due under the Act after submittal of a complete redesignation request.[3]

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[2]This is consistent with EPA's existing policy on redesignations as stated in an April 21, 1983 memorandum titled "Section 107 Designation Policy Summary." This memorandum states that in order for an area to be redesignated to attainment, the State must show that "actual enforceable emission reductions are responsible for the recent air quality improvement." This element of the policy retains its validity under the amended Act pursuant to section 193. [Note: other aspects of the April 21, 1983 memorandum have since been superseded by subsequent memorandums; interested parties should consult with OAQPS before relying on these aspects, e.g. those relating to required years of air quality data.]

[3]Under section 175A(c), however, the requirements of Part D remain in force and effect for the area until such time as it is redesignated. Upon redesignation to attainment, the requirements that became due under section 175A(c) after submittal of the complete redesignation request would no longer be applicable.

However, any requirements that came due prior to submittal of the redesignation request must be fully approved into the plan at or before the time EPA redesignates the area.

To avoid confusion concerning what requirements will be applicable for purposes of redesignation, Regions should encourage States to work closely with the appropriate Regional Office early in the process. This will help to ensure that a redesignation request submitted by the State has a high likelihood of being approved by EPA. Regions should advise States of the practical planning consequences if EPA disapproves the redesignation request or if the request is invalidated because of violations recorded during EPA's review. Under such circumstances, EPA does not have the discretion to adjust schedules for implementing SIP requirements. As a result, an area may risk sanctions and/or Federal implementation plan implementation that could result from failure to meet SIP submittal or implementation requirements.

a. Section 110 Requirements

Section 110(a)(2) contains general requirements for nonattainment plans. Most of the provisions of this section are the same as those contained in the pre-amended Act. We will provide guidance on these requirements as needed.[4]

b. Part D Requirements

Part D consists of general requirements applicable to all areas which are designated nonattainment based on a violation of the NAAQS. The general requirements are followed by a series of subparts specific to each pollutant. The general requirements appear in subpart 1. The requirements relating to O_3, CO, PM-10, SO_2, NO_2, and Pb appear in subparts 2 through 5. In those instances where an area is subject to both the general nonattainment provisions in subpart 1 as well as one of the pollutant-specific subparts, the general provisions may be subsumed within, or superseded by, the more specific requirements of subparts 2 through 5.

If an area was not classified under section 181 for O_3, or section 186 for CO, then that area is only subject to the provisions of subpart 1, "Nonattainment Areas in General." In addition to relevant provisions in subpart 1, an O_3 and CO area, which is classified, must meet all applicable requirements in subpart 2, "Additional Provisions for Ozone Nonattainment Areas," and subpart 3, "Additional Provisions for Carbon Monoxide

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[4]General guidance regarding the requirements for SIP's may be found in the "General Preamble to Title I of the 1990 Clean Air Act Amendments," 57 FR 13498 (April 16, 1992).

Nonattainment Areas," respectively, before the area may be redesignated to attainment. All PM-10 nonattainment areas (whether classified as moderate or serious) must similarly meet the applicable general provisions of subpart 1 and the specific PM-10 provisions in subpart 4, "Additional Provisions for Particulate Matter Nonattainment Areas." Likewise, SO_2, NO_2, and Pb nonattainment areas are subject to the applicable general nonattainment provisions in subpart 1 as well as the more specific requirements in subpart 5, "Additional Provisions for Areas Designated Nonattainment for Sulfur Oxides, Nitrogen Dioxide, and Lead."

i. Section 172(c) Requirements

This section contains general requirements for nonattainment plans. A thorough discussion of these requirements may be found in the General Preamble to Title I [57 FR 13498 (April 16, 1992)]. The EPA anticipates that areas will already have met most or all of these requirements to the extent that they are not superseded by more specific Part D requirements. The requirements for reasonable further progress, identification of certain emissions increases, and other measures needed for attainment will not apply for redesignations because they only have meaning for areas not attaining the standard. The requirements for an emission inventory will be satisfied by the inventory requirements of the maintenance plan. The requirements of the Part D new source review program will be replaced by the prevention of significant deterioration (PSD) program once the area has been redesignated. However, in order to ensure that the PSD program will become fully effective immediately upon redesignation, either the State must be delegated the Federal PSD program or the State must make any needed modifications to its rules to have the approved PSD program apply to the affected area upon redesignation.

ii. Conformity

The State must work with EPA to show that its SIP provisions are consistent with section 176(c)(4) conformity requirements. The redesignation request should include conformity procedures, if the State already has these procedures in place. Additionally, we currently interpret the conformity requirement to apply to attainment areas. However, EPA has not yet issued its conformity regulations specifying what areas are subject to the conformity requirement. Therefore, if a State does not have conformity procedures in place at the time that it submits a redesignation request, the State must commit to follow EPA's conformity regulation upon issuance, as applicable. If the State submits the redesignation request subsequent to EPA's issuance of the conformity regulations, and the conformity requirement became applicable to the area prior to submission, the State must adopt the applicable conformity requirements before EPA can redesignate the area.

5. Maintenance Plans

Section 107(d)(3)(E) of the amended Act stipulates that for an area to be redesignated, EPA must fully approve a maintenance plan which meets the requirements of section 175A. A State may submit both the redesignation request and the maintenance plan at the same time and rulemaking on both may proceed on a parallel track. Maintenance plans may, of course, be submitted and approved by EPA before a redesignation is requested. However, according to section 175A(c), pending approval of the maintenance plan and redesignation request, all applicable nonattainment area requirements shall remain in place.

Section 175A defines the general framework of a maintenance plan. The maintenance plan will constitute a SIP revision and must provide for maintenance of the relevant NAAQS in the area for at least 10 years after redesignation. Section 175A further states that the plan shall contain such additional measures, if any, as may be necessary to ensure such maintenance. Because the Act requires a demonstration of maintenance for 10 years after an area is redesignated (not 10 years after submittal of a redesignation request), the State should plan for some lead time for EPA action on the request. In other words, the maintenance demonstration should project maintenance for 10 years, beginning from a date which factors in the time necessary for EPA review and approval action on the redesignation request. In determining the amount of lead time to allow, States should consider that section 107(d)(3)(D) grants the Administrator up to 18 months from receipt of a complete submittal to process a redesignation request. The statute also requires the State to submit a revision of the SIP 8 years after the original redesignation request is approved to provide for maintenance of the NAAQS for an additional 10 years following the first 10-year period [see section 175A(b)].

In addition, the maintenance plan shall contain such contingency measures as the Administrator deems necessary to ensure prompt correction of any violation of the NAAQS [see section 175A(d)]. The Act provides that, at a minimum, the contingency measures must include a requirement that the State will implement all measures contained in the nonattainment SIP prior to redesignation. Failure to maintain the NAAQS and triggering of the contingency plan will not necessitate a revision of the SIP unless required by the Administrator, as stated in section 175A(d).

The following is a list of core provisions that we anticipate will be necessary to ensure maintenance of the relevant NAAQS in an area seeking redesignation from nonattainment to attainment. We therefore recommend that States seeking redesignation of a nonattainment area consider these provisions. However, any final EPA determination regarding the adequacy of a maintenance plan will be made following review of the plan submittal in light of the particular circumstances facing the area proposed for redesignation and based on all relevant information available at the time.

a. Attainment Inventory

The State should develop an attainment emissions inventory to identify the level of emissions in the area which is sufficient to attain the NAAQS.[5] This inventory should be consistent with EPA's most recent guidance on emission inventories for nonattainment areas available at the time and should include the emissions during the time period associated with the monitoring data showing attainment.[6]

Source size thresholds are 100 tons/year for SO_2, NO_2, and PM-10 areas, and 5 tons/year for Pb based upon 40 CFR 51.100(k) and 51.322, as well as established practice for AIRS data. The source size threshold for serious PM-10 areas is 70 tons/year

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[5]Where the State has made an adequate demonstration that air quality has improved as a result of the SIP (as discussed previously), the attainment inventory will generally be the actual inventory at the time the area attained the standard.

[6]The EPA's current guidance on the preparation of emission inventories for O_3 and CO nonattainment areas is contained in the following documents: "Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone: Volume I" (EPA-450/4-91-016), "Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone: Volume II" (EPA-450/4-91-014), "Emission Inventory Requirements for Ozone State Implementation Plans" (EPA-450/4-91-010), "Emission Inventory Requirements for Carbon Monoxide Implementation Plans" (EPA-450/4-91-011), "Guideline for Regulatory Application of the Urban Airshed Model" (EPA-450/4-91-013), "Procedures for Emission Inventory Preparation: Volume IV, Mobile Sources" (EPA-450/4-81-026d), and "Procedures for Preparing Emission Inventory Projections" (EPA-450/4-91-019). The EPA does not currently have specific guidance on attainment emissions inventories for SO_2. In lieu thereof, States are referred to the guidance on emissions data to be used as input to modeling demonstrations, contained in Table 9.1 of EPA's "Guideline on Air Quality Models (Revised)" (EPA-450/2-78-027R), July 1987, which is generally applicable to all criteria pollutants. Emission inventory procedures and requirements documents are currently being prepared by OAQPS for PM-10 and Pb; these documents are due for release by summer 1992.

according to Clean Air Act section 189(b)(3). However, the inventory should include sources below these size thresholds if these smaller sources were included in the SIP attainment demonstration. Where sources below the 100, 70, and 5 tons/year-size thresholds (e.g., areas with smaller source size definitions) are subject to a State's minor source permit program, these sources need only be addressed in the aggregate to the extent that they result in areawide growth.

For O_3 nonattainment areas, the inventory should be based on actual "typical summer day" emissions of O_3 precursors (volatile organic compounds and nitrogen oxides) during the attainment year. This will generally correspond to one of the periodic inventories required for nonattainment areas to reconcile milestones. For CO nonattainment areas, the inventory should be based on actual "typical CO season day" emissions for the attainment year. This will generally correspond to one of the periodic inventories required for nonattainment areas.

b. <u>Maintenance Demonstration</u>

A State may generally demonstrate maintenance of the NAAQS by either showing that future emissions of a pollutant or its precursors will not exceed the level of the attainment inventory, or by modeling to show that the future mix of sources and emission rates will not cause a violation of the NAAQS. Under the Clean Air Act, many areas are required to submit modeled attainment demonstrations to show that proposed reductions in emissions will be sufficient to attain the applicable NAAQS. For these areas, the maintenance demonstration should be based upon the same level of modeling. In areas where no such modeling was required, the State should be able to rely on the attainment inventory approach. In both instances, the demonstration should be for a period of 10 years following the redesignation.

Where modeling is relied upon to demonstrate maintenance, each plan should contain a summary of the air quality concentrations expected to result from application of the control strategy. In the process, the plan should identify and describe the dispersion model or other air quality model used to project ambient concentrations (see 40 CFR 51.46).

In either case, to satisfy the demonstration requirement the State should project emissions for the 10-year period following redesignation, either for the purpose of showing that emissions will not increase over the attainment inventory or for conducting modeling.[7] The projected inventory should consider future growth, including population and industry, should be consistent

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[7]Guidance for projecting emissions may be found in the emissions inventory guidance cited in footnote 6.

with the attainment inventory, and should document data inputs and assumptions. All elements of the demonstration (e.g., emission projections, new source growth, and modeling) should be consistent with current EPA modeling guidance.[8] For O_3 and CO, the projected emissions should reflect the expected actual emissions based on enforceable emission rates and typical production rates.

For CO, a State should address the areawide component of the maintenance demonstration either by showing that future CO emissions will not increase or by conducting areawide modeling. Preferably, the State should carry out hot-spot modeling that is consistent with the Guideline on Air Quality Models (Revised), in order to demonstrate maintenance of the NAAQS. In particular, if the nonattainment problem is related to a pattern of hot-spots then hot-spot modeling should generally be conducted. However, hot-spot modeling is not automatically required. For example, if the nonattainment problem was related solely to stationary point sources, or if highway improvements have been implemented and the associated emission reductions and travel characteristics can be qualitatively documented, then hot-spot modeling is not required. In such cases, adequate documentation as well as the concurrence of Headquarters is needed.

Any assumptions concerning emission rates must reflect permanent, enforceable measures. In other words, a State generally cannot take credit in the maintenance demonstration for reductions unless there are regulations in place requiring those reductions or the reductions are otherwise shown to be permanent. Therefore, the State will be expected to maintain its implemented control strategy despite redesignation to attainment, unless such measures are shown to be unnecessary for maintenance or are replaced with measures that achieve equivalent reductions (see additional discussion under "Contingency Plan"). Emission reductions from source shutdowns can be considered permanent and enforceable to the extent that those shutdowns have been reflected in the SIP and all applicable permits have been modified accordingly.

Modeling used to demonstrate attainment may be relied upon in the maintenance demonstration where the modeling conforms to current EPA guidance and where the State has projected no significant changes in the modeling inputs during the intervening time. Where the original attainment demonstration may no longer be relied upon, States will be expected to remodel using current

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[8]The EPA-approved modeling guidance may be found in the following documents: "Guideline on Air Quality Models (Revised)," OAQPS, RTP, NC (EPA-450/2-78-027R), July 1986; and "PM-10 SIP Development Guideline," OAQPS, RTP, NC (EPA-450/2-86-001), June 1987.

EPA referenced techniques.[9] This may be necessary where, for example, there has been a change in emissions or a change in the siting of new sources or modifications such that air quality may no longer be accurately represented by the existing modeling.

c. Monitoring Network

Once an area has been redesignated, the State should continue to operate an appropriate air quality monitoring network, in accordance with 40 CFR Part 58, to verify the attainment status of the area. The maintenance plan should contain provisions for continued operation of air quality monitors that will provide such verification. In cases where measured mobile source parameters (e.g., vehicle miles traveled congestion) have changed over time, the State may also need to perform a saturation monitoring study to determine the need for, and location of, additional permanent monitors.

d. Verification of Continued Attainment

Each State should ensure that it has the legal authority to implement and enforce all measures necessary to attain and to maintain the NAAQS. Sections 110(a)(2)(B) and (F) of the Clean Air Act, as amended, and regulations promulgated at 40 CFR 51.110(k), suggest that one such measure is the acquisition of ambient and source emission data to demonstrate attainment and maintenance.

Regardless of whether the maintenance demonstration is based on a showing that future emission inventories will not exceed the attainment inventory or on modeling, the State submittal should indicate how the State will track the progress of the maintenance plan. This is necessary due to the fact that the emission projections made for the maintenance demonstration depend on assumptions of point and area source growth.

One option for tracking the progress of the maintenance demonstration, provided here as an example, would be for the State to periodically update the emissions inventory. In this case, the maintenance plan should specify the frequency of any planned inventory updates. Such an update could be based, in part, on the annual AIRS update and could indicate new source growth and other changes from the attainment inventory (e.g., changes in vehicle miles travelled or in traffic patterns). As an alternative to a complete update of the inventory, the State may choose to do a comprehensive review of the factors that were used in developing the attainment inventory to show no significant change. If this review does show a significant change, the State should then perform an update of the inventory.

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[9]See references for modeling guidance cited in footnote 8.

Where the demonstration is based on modeling, an option for tracking progress would be for the State to periodically (typically every 3 years) reevaluate the modeling assumptions and input data. In any event, the State should monitor the indicators for triggering contingency measures (as discussed below).

e. Contingency Plan

Section 175A of the Act also requires that a maintenance plan include contingency provisions, as necessary, to promptly correct any violation of the NAAQS that occurs after redesignation of the area. These contingency measures are distinguished from those generally required for nonattainment areas under section 172(c)(9) and those specifically required for O_3 and CO nonattainment areas under sections 182(c)(9) and 187(a)(3), respectively. For the purposes of section 175A, a State is not required to have fully adopted contingency measures that will take effect without further action by the State in order for the maintenance plan to be approved. However, the contingency plan is considered to be an enforceable part of the SIP and should ensure that the contingency measures are adopted expediently once they are triggered. The plan should clearly identify the measures to be adopted, a schedule and procedure for adoption and implementation, and a specific time limit for action by the State. As a necessary part of the plan, the State should also identify specific indicators, or triggers, which will be used to determine when the contingency measures need to be implemented.

Where the maintenance demonstration is based on the inventory, the State may, for example, identify an "action level" of emissions as the indicator. If later inventory updates show that the inventory has exceeded the action level, the State would take the necessary steps to implement the contingency measures. The indicators would allow a State to take early action to address potential violations of the NAAQS before they occur. By taking early action, States may be able to prevent any actual violations of the NAAQS and, therefore, eliminate the need on the part of EPA to redesignate an area to nonattainment.

Other indicators to consider include monitored or modeled violations of the NAAQS (due to the inadequacy of monitoring data in some situations). It is important to note that air quality data in excess of the NAAQS will not automatically necessitate a revision of the SIP where implementation of contingency measures is adequate to address the cause of the violation. The need for a SIP revision is subject to the Administrator's discretion.

The EPA will review what constitutes a contingency plan on a case-by-case basis. At a minimum, it must require that the State will implement all measures contained in the Part D nonattainment plan for the area prior to redesignation [see section 175A(d)]. This language suggests that a State may submit a SIP revision at the time of its redesignation request to remove or reduce the stringency of control measures. Such a revision can be approved by EPA if it provides for compensating equivalent reductions. A demonstration that measures are equivalent would have to include appropriate modeling or an adequate justification. Alternatively, a State might be able to demonstrate (through EPA-approved modeling) that the measures are not necessary for maintenance of the standard. In either case, the contingency plan would have to provide for implementation of any measures that were reduced or removed after redesignation of the area.

Summary

As stated previously, this memorandum consolidates EPA's redesignation and maintenance plan guidance and Regions should rely upon it as a general framework in drafting Federal Register notices. It is strongly suggested that the Regional Offices share this document with the appropriate States. This should give the States a better understanding of what is expected from a redesignation request and maintenance plan under existing policy. Any necessary changes to existing Agency policy will be made through our action on specific redesignation requests and the review of section 175A maintenance plans for these particular areas, both of which are subject to notice and comment rulemaking procedures. Thus, in applying this memorandum to specific circumstances in a rulemaking, Regions should consider the applicability of the underlying policies to the particular facts and to comments submitted by any person. If your staff members have questions which require clarification, they may contact Sharon Reinders at (919) 541-5284 for O_3- and CO-related issues, and Eric Ginsburg at (919) 541-0877 for SO_2-, PM-10-, and Pb-related issues.

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Appendix I

Public Comment Notice, Public Hearing Agenda, and
Transcript of September 3 Public Hearing.

Appendix J

Ancillary Maintenance Demonstration Modeling

ANCILLARY MAINTENANCE DEMONSTRATION MODELING

This Appendix provides a description of ancillary episodic and annual modeling that was undertaken to address certain issues that were identified during the coarse of the public comment period for the Draft Northern Ada County PM_{10} SIP. Specifically four changes were made to the PM_{10} modeling database:

1) The on-road motor vehicle emissions budget (MVEB) for NOx and VOC between the SIP submission date and 2010 was increased to 1999 baseline levels, plus an additional 10% buffer, to establish a new MVEB for the SIP for the period 1999 to 2009. The MVEB from 2010 until 2015 is based on the projected 2010 motor vehicle emissions. The 2015 maintenance year MVEB was determined in the original draft SIP, as described in Section 4.3 of the SIP.

2) The future year PM_{10} point source inventory was modified to:
   a) remove certain construction-related sources that were over-counted in the original future year inventory;
   b) reduce the permitted levels for one particular construction-related source; and
   c) account for the potential sale of PM_{10} emission credits from Croman Corporation.

3) CAMx was rerun for two of the future years to ensure that the 24-hour PM_{10} standard is maintained with the changes incorporated into the future year emissions inventory. Specifically:
   a) CAMx was rerun for the 2015 attainment year using the revised point source inventory and the 1991 "worst case" meteorological inputs, and
   b) CAMx was rerun for the 2010 intermediate year using the revised point source inventory, the higher 1999-2010 MVEB, and the 1991 "worst case" meteorological inputs.

4) The annual speciated linear rollback model was rerun to ensure maintenance of the annual PM_{10} standard through 2010 using the MVEB NOx changes described above.

The emission changes and the modeling results are described in more detail in the sections that follow.

J.1 MODIFICATIONS TO FUTURE YEAR EMISSIONS

J.1.1 Point Source Revisions

Industrial emissions were reassessed for future years to include permit changes for certain construction-related sources, to remove multiply-counted sources, and to accommodate future emissions trading needs. The changes are summarized here.

PM_{10} emissions from Nelson Construction are associated with portable crushers. Nelson Construction has three portable crusher units that relocated several times during 1999.

Emissions from these 3 portable units were erroneously shown operating at 8 locations during the future year episodic modeling runs. Emissions from the 3 crushers were reassigned only to the locations where the crushers were operating during the December 1999 modeling episode. Additionally, new permits were issued to limit two of the crusher units to a facility-wide emission of 20 tons per year of particulate emissions and the third unit to 40 tons of particulate per year.

C. Wright Construction was one of several facilities originally identified by DEQ as needing a Tier II Operating Permit to ensure a successful Maintenance Plan attainment demonstration. A draft permit was written to lower the facility's allowable emissions to a level near its actual emissions. Although this was sufficient for the Maintenance Plan, facility modeling showed that National Ambient Air Quality Standards (NAAQs) were not protected. As a result, DEQ is working with the facility to revise the permit to lower emissions further. DEQ will issue a new permit in October 2002 that is consistent with the Maintenance Plan requirements and that limits emissions to show full NAAQs compliance.

The final change in the industrial emissions modeling was a result of local interest in buying emissions from a facility that was no longer operational but still had an active air quality permit. Croman, Inc., ceased operations in 1999. Micron Technology has expressed interest in purchasing emissions credit from Croman. Micron is currently negotiating with DEQ on the amount of emission credits available. The Croman emissions for dispersion modeling were set to define the upper limit of emissions potentially available for purchase. The exact level will be negotiated between Micron Technology and DEQ.

J.1.2 On-Road Mobile Emission Revisions

The on-road motor vehicle emissions budget to be set for years 1999-2009 is established to protect the PM_{10} 24-hour and annual standard(during that time period. This section describes how the budget was determined for direct PM_{10} emissions, and for NO_X and VOC, which are the two most important PM_{10} precursors.

On-road PM_{10} emissions are dominated by road dust, which increases in proportion to growth in vehicle miles traveled (VMT). Since VMT is always increasing during the 1999-2015 period, the PM_{10} emissions budget is thus set to the estimated 2015 emissions. As detailed in Section 4.3 of the SIP, a 33% buffer is added to protect the annual standard through future planning horizon years for transportation conformity purposes. It is quite like that the horizon year will be 25-years distant from approval of the MVEB.

MOBILE6 runs were made for Ada County to determine the budgets for on-road VOC and NO_X. MOBILE6 modeling runs were made for winter conditions (with temperature inputs from the January 1991 episode) for every year from 1999 to 2010; the resulting fleet-average emission factors were then multiplied by the COMPASS Ada County VMT forecasts to estimate Ada County on-road emissions. Table J-1 shows the VMT, MOBILE6 NO_X and VOC emission factors, and NO_X and VOC emissions for Ada County for the years 1999 to 2010. Figure J-1 shows the VMT, emission factors, and emissions relative to 1999.

Table J-1. Winter VMT, MOBILE6 emission factors, and estimated emissions for Ada County, 1999-2010.

		Emission Factor (g/mi)		Emissions (tons/day)	
Year	**VMT**	**NOx**	**VOC**	**NOx**	**VOC**
1999	5,712,158	3.57	2.12	22.49	13.37
2000	5,935,241	3.44	2.00	22.48	13.10
2001	6,158,324	3.29	1.89	22.35	12.83
2002	6,381,407	3.17	1.76	22.27	12.37
2003	6,604,490	3.00	1.63	21.86	11.86
2004	6,827,572	2.72	1.45	20.46	10.91
2005	7,050,655	2.51	1.32	19.54	10.29
2006	7,273,738	2.27	1.19	18.19	9.54
2007	7,496,821	2.12	1.11	17.54	9.15
2008	7,719,904	1.95	0.99	16.58	8.46
2009	7,942,987	1.79	0.91	15.65	7.97
2010	8,166,070	1.64	0.84	14.77	7.52

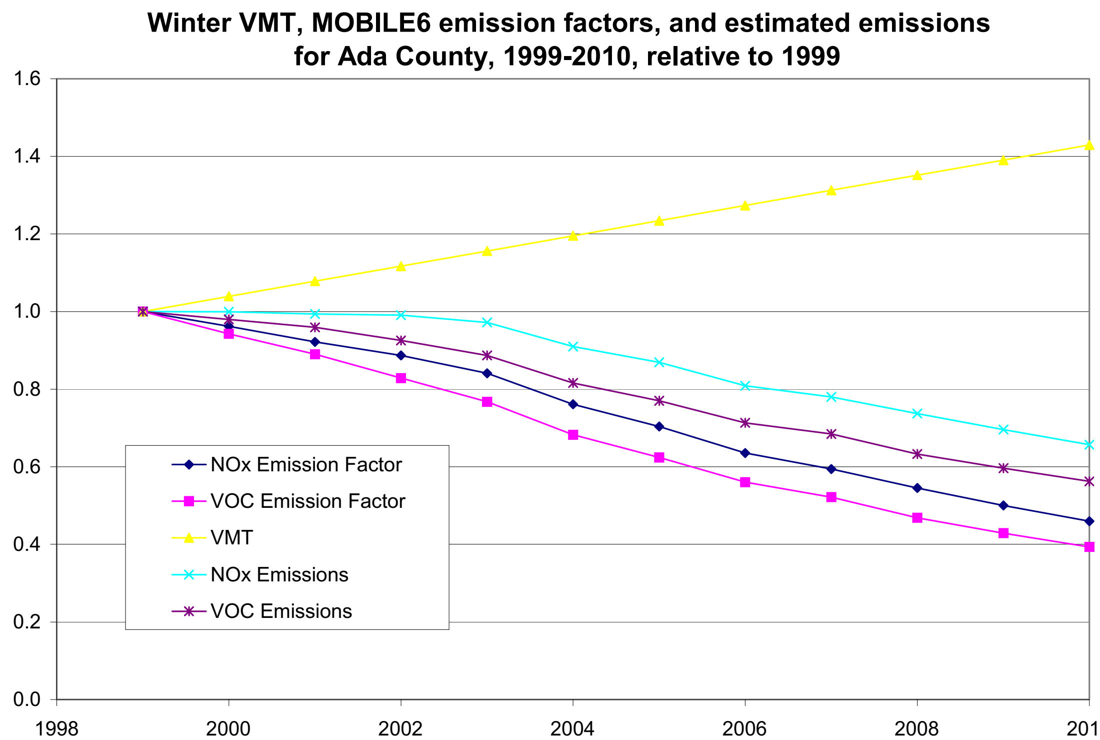


Figure J-1. Winter VMT, MOBILE6 emission factors, and estimated emissions for Ada County, 1999-2010, relative to 1999.

Emission factors are decreasing during this time period because of fleet turnover, with newer vehicles meeting stricter federal emission standards (Tier 1 and 2002 Tier 2 light-duty vehicle standards, and 2007 heavy-duty standards). These emission factors are decreasing at a faster rate than VMT is increasing during 1999-2010. As a result, the estimated on-road NO_X and VOC emissions are estimated to decrease each year between 1999 and 2010. The 1999 emissions, with a ten percent increase as a buffer, were used to set the MVEB budgets.

J.2 EPISODIC PM_{10} ESTIMATES FOR 2010 AND 2015

CAMx was rerun for two future years: 2015 to ensure that 24-hour PM_{10} is not exceeded in the attainment year with the modifications to the point source inventory; and 2010 to ensure that 24-hour PM_{10} is not exceeded in the intermediate year with the revised NO_x and VOC MVEB in combination with the modified point source inventory. In both cases, the episode modeled was the January 2-8, 1991 period ("worst case" meteorology), identically following the approach described in Appendix B, Section 7.2 "PM_{10} Estimates with Wood Burning Ban".

To summarize from that section, when CAMx was run for the January 1991 case for the future years with no burn ban controls in place, the simulated 24-hour PM_{10} on January 2 at the Boise Fire Station Number 5 monitor (BFS5) exceeded the voluntary trigger of 74 $\mu g/m^3$ in all three future years. Therefore, the emissions inventory was revised for January 3-9 to include a 43% reduction in residential wood combustion emissions. While the rule calls for a voluntary ban in both Ada and Canyon Counties, controls were only applied to the modeling inventory in Ada County. The voluntary wood burning ban was shown to be adequate to maintain the 24-hour PM_{10} standard in all future years, thus negating the need to run the model with the mandatory ban. The two CAMx runs documented in this Appendix were both run with the voluntary wood burning ban in this manner. Therefore, the results reported here are directly comparable to those described in Appendix B, Section 7.2.

J.2.1 Results for 2015

Table J-2 displays the predicted peak 24-hour PM_{10} in Ada County for each day of the January episode when the voluntary burn ban was included in the emissions inventory and the point sources were revised as described above. On January 5th, predicted concentrations at BFS5 reached 116 $\mu g/m^3$. This would trigger the mandatory burn ban through the remainder of the episode (January 6-9); however, the additional controls were not modeled as the voluntary ban was predicted to be sufficient to reach attainment.

Figure J-2 displays the simulated domain-wide distribution of 24-hour PM_{10} on January 5, while Figure J-3 shows the speciated breakdown at BFS5 on January 5.

Table J-2. Predicted peak 24-hour PM_{10} ($\mu g/m^3$) in Ada County in 2015 over the January 1991 meteorological episode. The column labeled "Original" is from Appendix B, Section 7.2 and included a 43% voluntary reduction in residential wood smoke emissions in Ada County; the column labeled "Revised" is similar but includes revisions to the future year point source inventory.

Date	Original	Revised
Jan 2	98	96
Jan 3	98	77
Jan 4	106	102
Jan 5	126	125
Jan 6	77	78
Jan 7	44	39
Jan 8	121	90
Jan 9	46	42

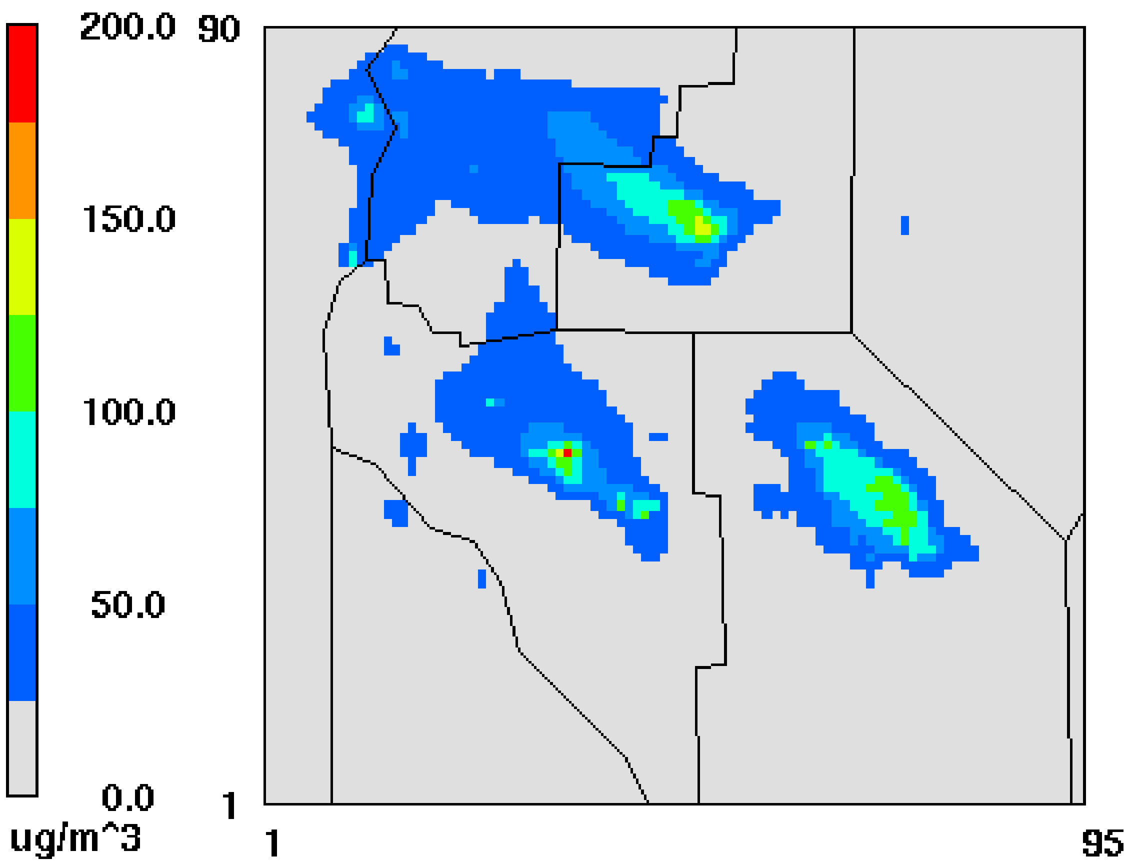
J.2.2 Results for 2010

Table J-3 displays the predicted peak 24-hour PM_{10} in Ada County for each day of the January episode when the voluntary burn ban was included in the emissions inventory, the point sources were revised as described above, and the new intermediate 1999-2010 NOx and VOC MVEB was implemented. On January 5th, predicted concentrations at BFS5 reached 106 $\mu g/m^3$. This would trigger the mandatory burn ban through the remainder of the episode (January 6-9); however, the additional controls were not modeled as the voluntary ban was predicted to be sufficient to reach attainment. Changes between the "Original" and "Revised" daily 24-hour PM_{10} are consistent with those seen in Table J-1; therefore, the revisions to the point source inventory dominate the signal, and the revised NOx and VOC MVEB have very little impact on the simulated peak PM_{10} in Ada County.

Figure J-4 displays the simulated domain-wide distribution of 24-hour PM_{10} on January 5, while Figure J-5 shows the speciated breakdown at BFS5 on January 5.

Surface Layer 24-Hour PM10

CAMx IDEQ 91_2015d Jan 2-9 1991



January 5,1991 0:00:00
Min= 0.0 at (1,1), Max= 202.0 at (36,41)

Figure J-2. Spatial distribution of predicted 24-hour PM_{10} on January 5, 1991 for the revised 2015 future year case.

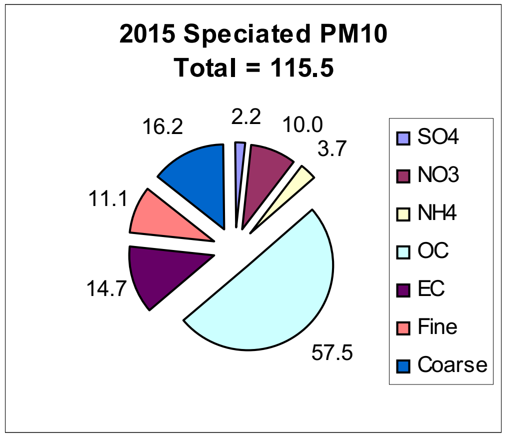


Figure J-3. Speciated breakdown of total PM_{10} predicted at BFS5 on January 5, 1991 for the revised 2015 future year case.

Table J-3. Predicted peak 24-hour PM_{10} ($\mu g/m^3$) in Ada County in 2010 over the January 1991 meteorological episode. The column labeled "Original" is from Appendix B, Section 7.2 and included a 43% voluntary reduction in residential wood smoke emissions in Ada County; the column labeled "Revised" is similar but includes revisions to the future year point source inventory and the new 1999-2010 NOx and VOC MVEB.

Date	Original	Revised
Jan 2	96	94
Jan 3	95	74
Jan 4	103	101
Jan 5	122	114
Jan 6	72	71
Jan 7	42	36
Jan 8	119	89
Jan 9	44	39

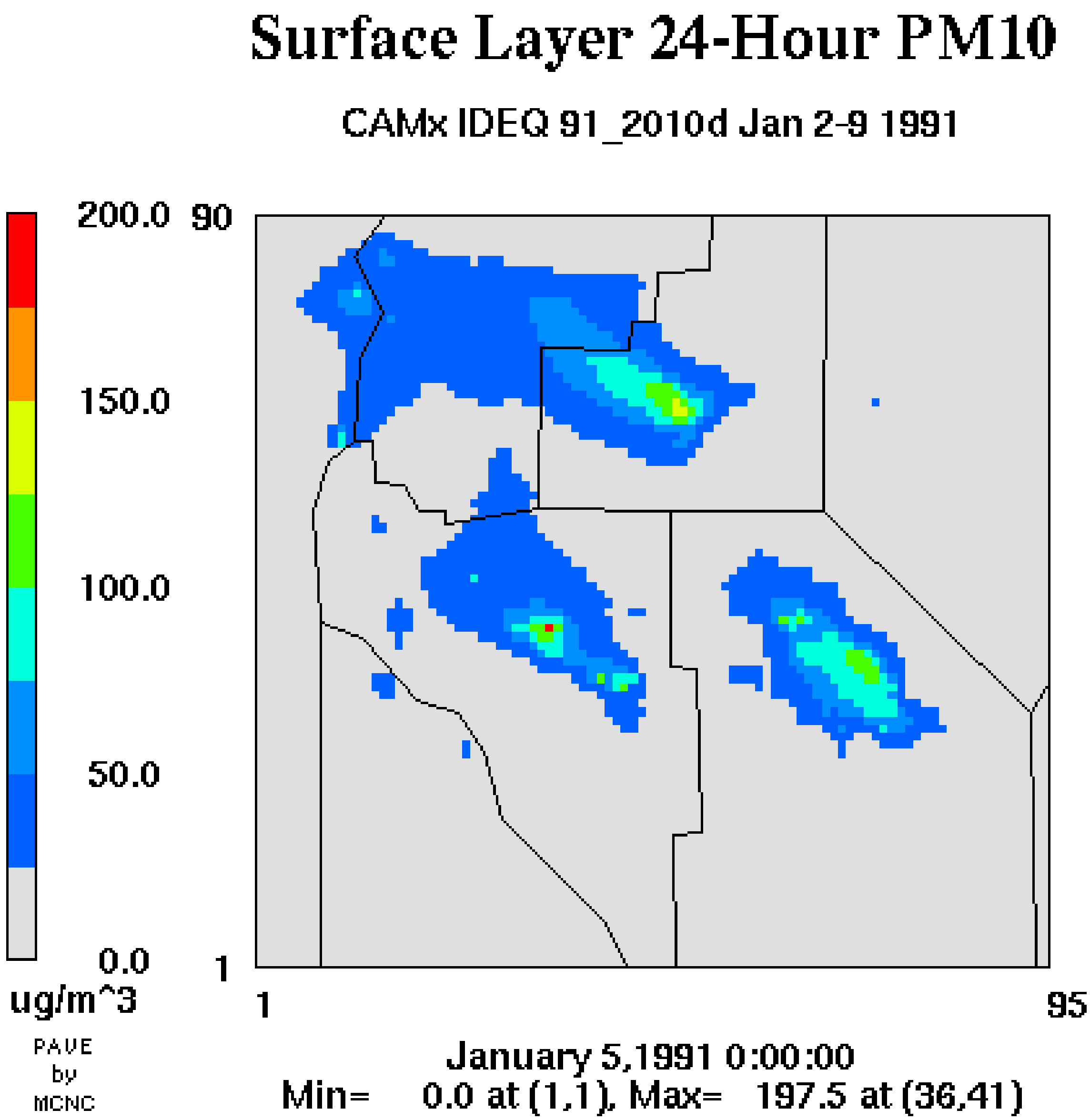


Figure J-4. Spatial distribution of predicted 24-hour PM_{10} on January 5, 1991 for the revised 2010 future year case.

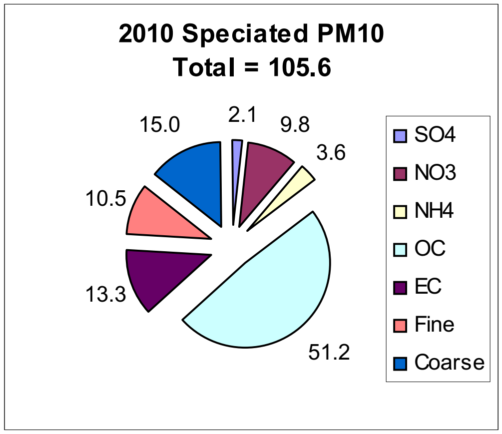


Figure J-5. Speciated breakdown of total PM_{10} predicted at BFS5 on January 5, 1991 for the revised 2010 future year case.

J.3 ANNUAL PM_{10} ESTIMATES FOR 2010

The annual PM_{10} modeling was performed using a speciated linear rollback methodology, as described in Appendix E. Appendix E shows that the annual standard is not expected to be exceeded out to the year 2030. However, with the changes to the on-road mobile emission inventory out to 2010, it was necessary to re-apply the rollback model for 2010 with these modifications reflected in order to ensure maintenance of the annual PM_{10} standard in the interim 1999-2010 period.

Note that the speciated linear rollback model applied in this study only accounts for the secondary formation of sulfate from SOx and nitrates from NOx, while ignoring any contributions to organic aerosol from VOC. Rollback modeling for particle nitrate is complicated by the highly non-linear response to assumed levels of available nitric acid and ammonium. Therefore, three cases were investigated, a case with no secondary formation (i.e., all sulfate and nitrates are from primary emissions of those components), a NOx-limited case (particle nitrate is limited by available NOx but ammonia is abundant), and an ammonia-limited case (particle nitrate is limited by available ammonia but NOx is abundant).

Results of the revised annual modeling for 2010 are summarized in Table J-4. Slightly higher PM_{10} concentrations are predicted due to higher on-road mobile NO_x emissions, but only in the NO_x limited case. In all cases, the higher on-road NOx emissions in 2010 do not lead to simulated PM_{10} levels above the annual standard.

Table J-4. Annual rollback predicted PM_{10} levels in 2010 using higher NO_x emissions to reflect higher on-road emissions.

Case 1: No Secondary Aerosol	Annual Average (μg/m^3)
Geologic	12.3
Organic	7.5
Elemental Carbon	2.0
Ammonium Sulfate	1.9
Ammonium Nitrate	3.7
Total PM_{10}	**34.0**
Case 2: NO_x Limited	
Geologic	12.3
Organic	7.5
Elemental Carbon	2.0
Ammonium Sulfate	3.5
Ammonium Nitrate	5.1
Total PM_{10}	**37.7**
Case 3: NH_3 Limited	
Geologic	12.3
Organic	7.5
Elemental Carbon	2.0
Ammonium Sulfate	3.5
Ammonium Nitrate	1.7
Total PM_{10}	**33.5**

Appendix K

Maintenance Demonstration Modeling
With Revised Paved Road Dust Estimates

MAINTENANCE DEMONSTRATION MODELING WITH REVISED PAVED ROAD DUST ESTIMATES

This Appendix provides a description of revised episodic and annual modeling that was undertaken to address an issue concerning future year estimates of paved road dust emissions. This issue was identified by COMPASS subsequent to the IDEQ submittal of the Northern Ada County PM_{10} SIP to the U.S. EPA, Region X.

The specific problem identified by COMPASS was an error in Desert Research Institute's application of COMPASS VMT growth rates to base year paved road dust emissions for the three future years of 2010, 2015, and 2020. No errors were found for unpaved road dust. Resolution of the error resulted in a 12%, 17%, and 21% increase in annual average day paved road dust PM_{10} emissions in 2010, 2015, and 2020, respectively (based on sums over Ada plus Canyon Counties combined). The original and revised fugitive (paved + unpaved) road dust emissions are shown in Table K-1 below. Since these emission estimates were directly used in the episodic and annual PM_{10} Maintenance Plan demonstration modeling for Ada County, these errors may have ramifications for the PM_{10} modeling results as described in the main SIP document and associated appendices. This appendix describes how the episodic and annual air quality modeling components of the PM_{10} maintenance plan were repeated with revised future year paved road dust emission estimates.

Table K-1. Original and revised annual average day fugitive (paved + unpaved) road dust PM_{10} emissions (TPY) in 2010, 2015, and 2020, for Ada and Canyon Counties combined.

	2010 (TPY)	2015 (TPY)	2020 (TPY)
Original*	32,483	36,533	40,514
Revised	36,301	42,593	48,815

*See Tables 4-4 through 4-6 in Section 4 of the SIP documentation.

K.1 EPISODIC MODELING APPROACH

As described in Section 6 and Appendix B, Section 7, of the SIP documentation, the meteorology of two historical PM_{10} episodes (January 2-9, 1991, and December 20-26, 1999) were used in conjunction with emission estimates for the three future years of 2010, 2015, and 2020 to estimate future episodic PM_{10} levels in Ada County. The purpose of this was to demonstrate that emission projections, in combination with control measures that are currently "on the books", would not lead to any future exceedances of the 24-hour PM_{10} National Ambient Air Quality Standards. The January 1991 period was the last actual PM_{10} exceedance recorded in Ada County, whereas the December 1999 period exhibited high (non-exceedance) PM_{10} levels during an intensive measurement period.

Future year modeling with the January 1991 episode was performed with paved road dust estimates scaled down by a factor of 2.4 because this episode included widespread snow cover (as determined via reconciliation with ambient monitoring data); unpaved road dust was completely removed for this episode for the same reason (see Section 6, and Appendix B, Section 7). Therefore, the errors identified in the future estimates of road dust emissions would have little or no bearing on the outcome of modeling results for this particular episode. However, future year runs based upon the December 1999 meteorology did include full road dust emission estimates as there was no snow cover present. Whereas future year modeling in conjunction with the December 1999 meteorology demonstrated that PM_{10} levels would remain below the 24-hour PM_{10} standard of 150 $\mu g/m^3$ with no addition controls necessary, the errors in road dust emissions might cause projected PM levels to increase above the standard for some of the future years (although probably not all).

Therefore, the December 1999 future year modeling was revised following the steps below:

1) Revised projected annual average day paved road dust emission estimates were obtained from the Desert Research Institute via the IDEQ for the years 2010, 2015, and 2020.
2) These emissions were processed using EPS2 to generate episodic model-ready formats, and were merged with all other source estimates to generate new final model-ready input files. Since the increases in revised paved road dust rates might lead to exceedances of the 24-hour PM_{10} standard using the December 1999 meteorological scenario, the 43% voluntary reduction in residential wood smoke emissions was applied in the revised modeling reported here. The voluntary wood burning ban was not originally applied for the December 1999 forecasts described in Appendix B, even though PM_{10} levels reached the thresholds that would cause the IDEQ to call the voluntary ban[1].
3) The 2010, 2015, and 2020 cases were rerun through CAMx using the December 20-24, 1999 meteorological period following the methodology described in Appendix B, Section 7.1.

The emission modifications described in Appendix J were also not considered in the revised modeling reported here. The Appendix J modifications included higher motor vehicle emissions budgets for NOx and VOC in 2010, and lower point source emissions in 2010 and 2015 as a result of removing over-counted construction-related sources, reducing permit levels for two specific sources, and accounting for the sale of PM_{10} emission credits from Croman Corporation. As shown in Appendix J, the higher motor vehicle budget in 2010 had practically zero impact on PM_{10} levels using the January 1991 meteorological scenario, and so the same was assumed here. The altered point source emissions in 2010 and 2015 resulted in much lower PM_{10} levels in Ada County using the January 1991 meteorology (see Appendix J, Section J.2). Thus, use of the original (Appendix B) point source inventory in the revised runs described here should yield a conservative (high) estimate of future PM_{10} levels for the conditions of the December 1999 meteorology.

[1] To summarize from Appendix B, Section 7.2, CAMx was run for the January 1991 case for all three future years with the voluntary wood burning ban in place. While the rule calls for a voluntary ban in both Ada and Canyon Counties, controls were only applied to the modeling inventory in Ada County. The voluntary wood burning ban was shown in Appendix B to be adequate to maintain the 24-hour PM_{10} standard in all future years, thus negating the need to run the model with the mandatory ban. The three CAMx runs documented in this Appendix were all run with the voluntary wood burning ban in this manner for the entirety of the December 20-24, 1999 period.

K.2 EPISODIC PM_{10} ESTIMATES FOR 2010, 2015, and 2020

Table K-2 displays the predicted peak 24-hour PM_{10} in Ada County for each day of the December 1999 episode and for all three future years when the revised paved road dust estimates and voluntary burn ban was included in the emissions inventory. Note that the 24-hour PM_{10} standard is maintained in Ada County for all years.

Figures K-1 through K-3 display the simulated domain-wide distribution of 24-hour PM_{10} on December 24, while Figure K-4 shows the speciated breakdown at BFS5 on December 24.

Table K-2

(A) Original predicted peak 24-hour PM_{10} ($\mu g/m^3$) in Ada County in 2010, 2015, and 2020 over the December 1999 meteorological episode (from Appendix B, Section 7.1).

Date	2010	2015	2020
Dec 20	110	114	117
Dec 21	78	84	88
Dec 22	84	88	95
Dec 23	96	104	110
Dec 24	127	139	143

(B) Revised predicted peak 24-hour PM_{10} ($\mu g/m^3$) in Ada County in 2010, 2015, and 2020 over the December 1999 meteorological episode, which includes corrected paved road dust estimates and the 43% voluntary wood burning ban.

Date	2010	2015	2020
Dec 20	107	112	116
Dec 21	76	81	89
Dec 22	80	83	91
Dec 23	91	99	107
Dec 24	108	114	120

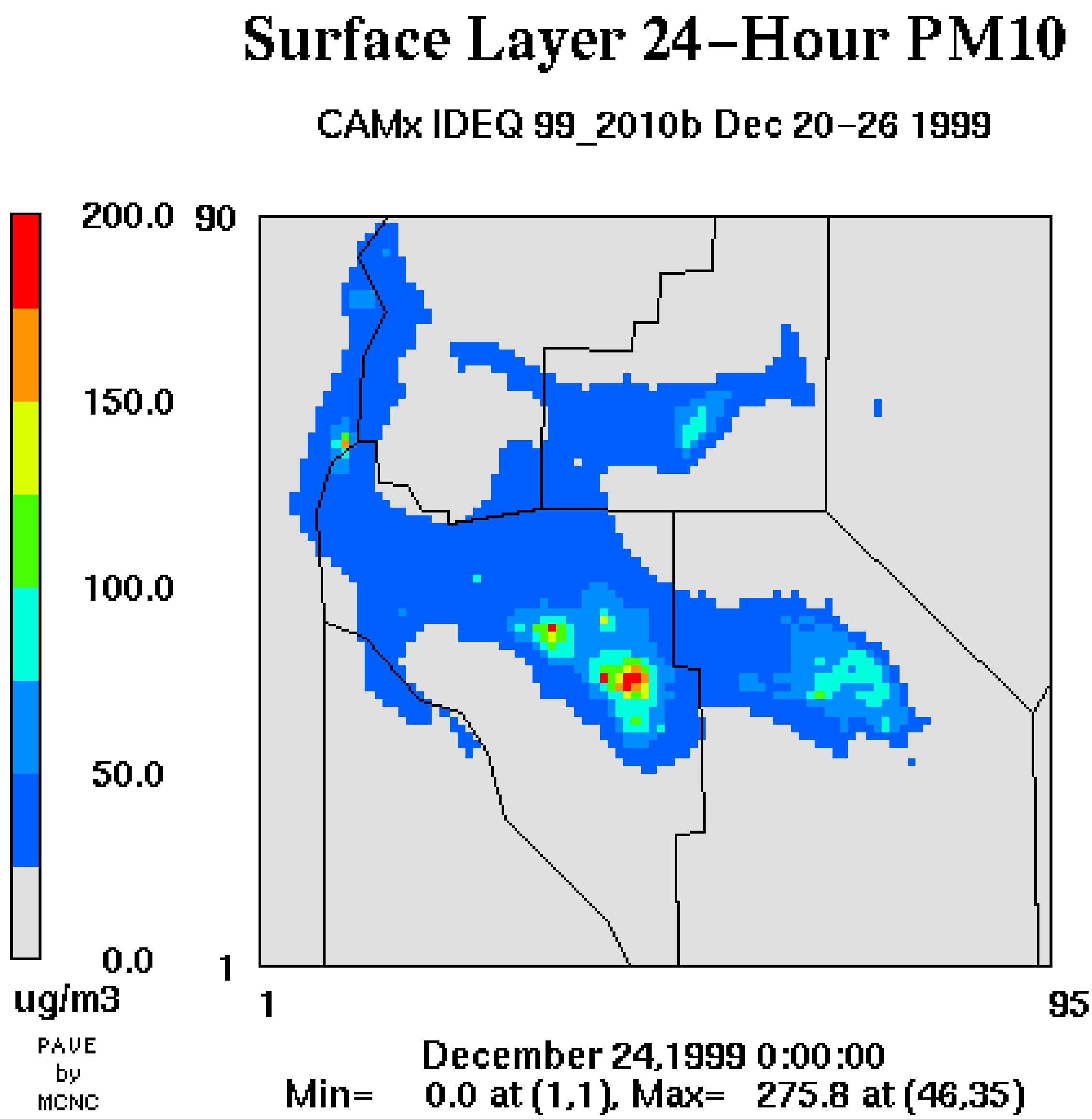


Figure K-1. Spatial distribution of predicted 24-hour PM_{10} on December 24, 1999 for the revised 2010 future year case.

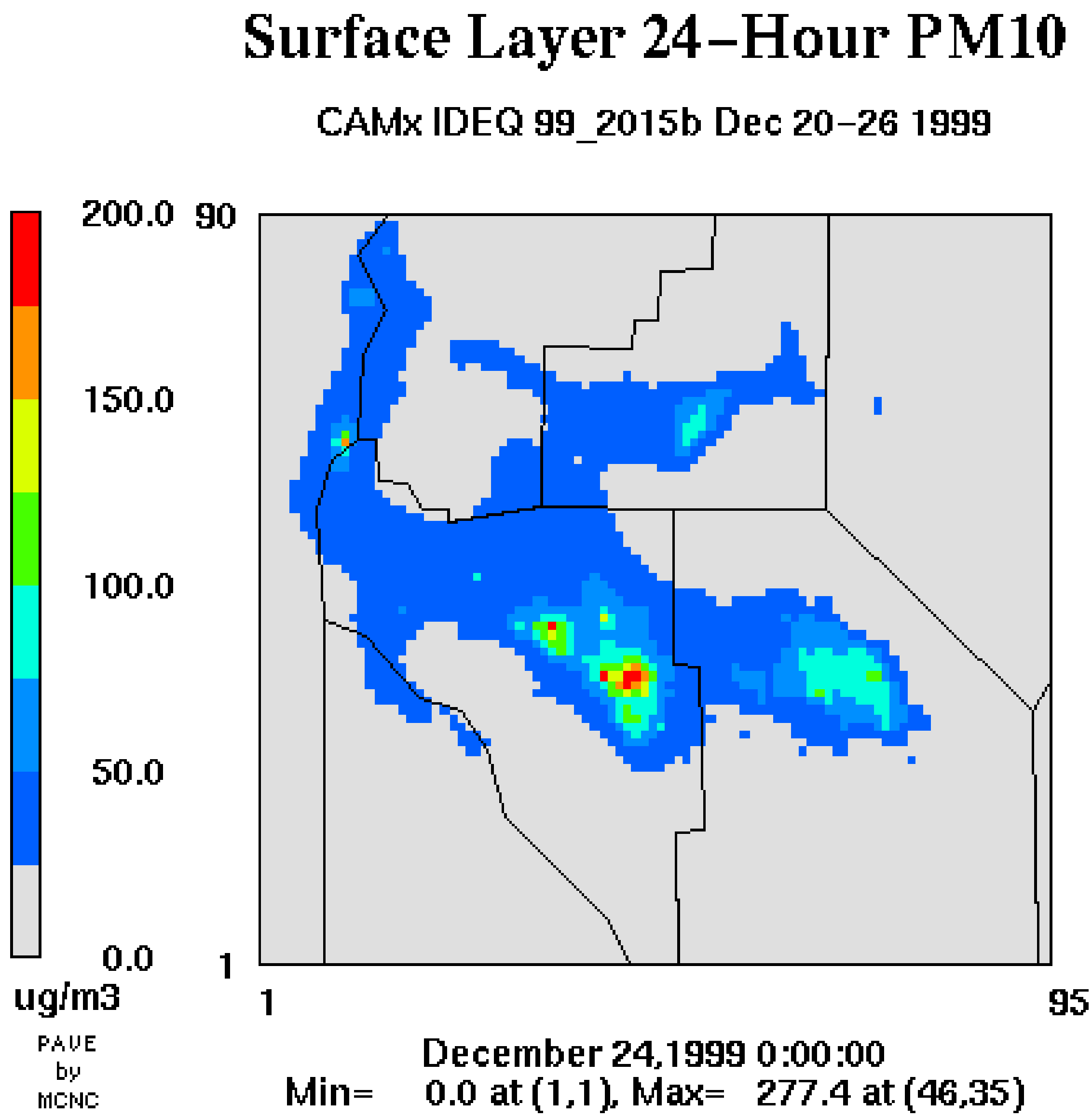


Figure K-2. Spatial distribution of predicted 24-hour PM_{10} on December 24, 1999 for the revised 2015 future year case.

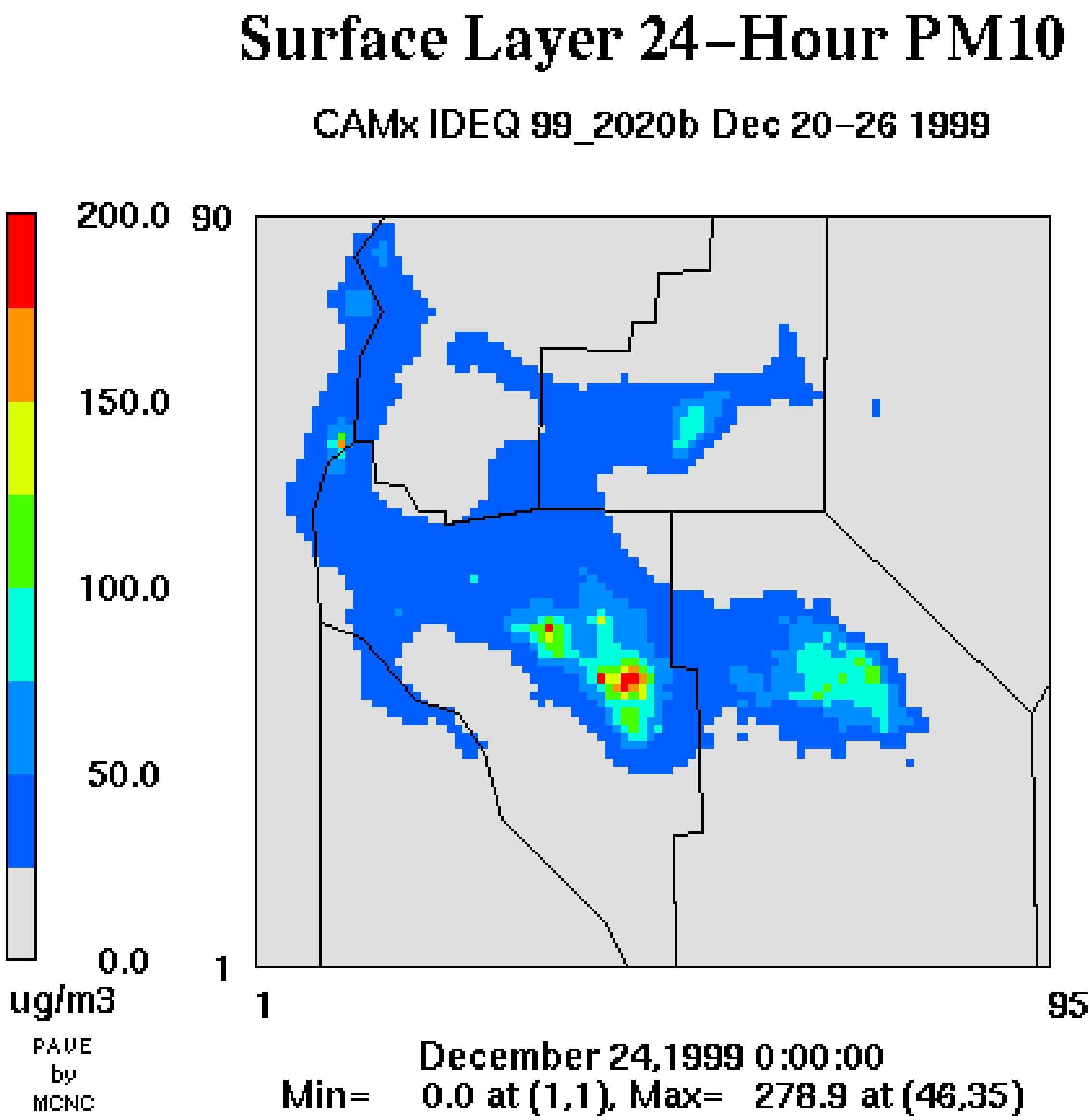
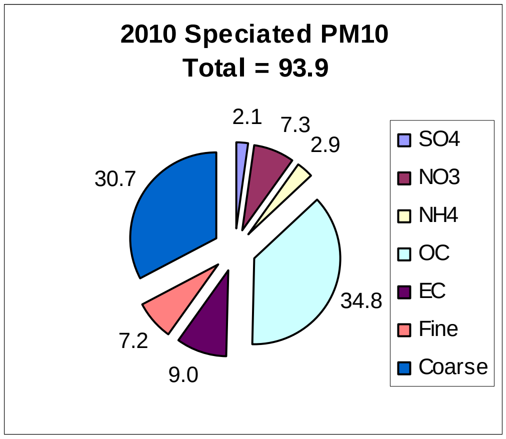
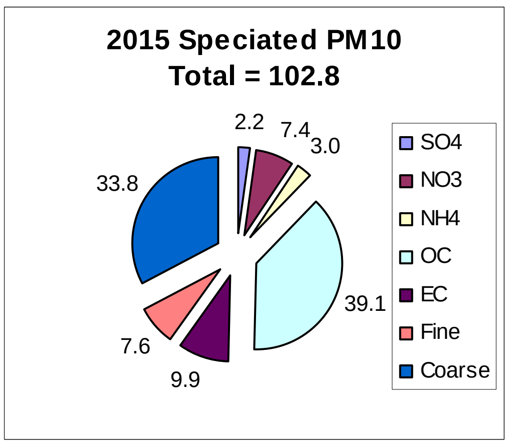


Figure K-3. Spatial distribution of predicted 24-hour PM_{10} on December 24, 1999 for the revised 2020 future year case.





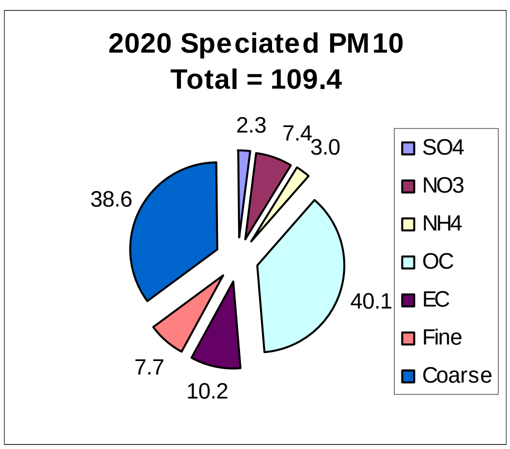


Figure K-4. Speciated breakdown of total PM_{10} predicted at BFS5 on December 24, 1999 for the revised 2010, 2015 and 2020 future year cases.

K.3 REVISED ANNUAL PM_{10} ESTIMATES

The annual PM_{10} modeling was performed using a speciated linear rollback methodology, as described in Appendix E. Appendix E shows that the annual standard is not expected to be exceeded out to the year 2030. In Appendix J, the changes to the on-road mobile NOx emission budget out to 2010 was applied to the rollback model for 2010 in order to ensure maintenance of the annual PM_{10} standard in the interim 1999-2010 period. Besides showing that the annual standard is maintained in 2010 with the increased mobile emissions budget, there was relatively small sensitivity in nitrate levels to the assumptions of NOx- and ammonia-limited formation.

The annual results described in Appendix E were adjusted to account for the corrected levels of paved road dust. The factors of 1.12, 1.17, and 1.21 were applied to the geologic component for 2010, 2015, and 2020, respectively, based upon the increases in Ada and Canyon County paved road dust emissions that result from corrected VMT estimates. The geologic component is actually comprised of contributions from paved road dust, unpaved road dust, construction activities, and agricultural activities. Therefore, these factors to adjust the entire geologic component for increased pave road dust are rather conservative.

Results of the revised annual estimates for 2010, 2015, and 2020 are summarized in Table K-2. The annual standard is maintained for all years.

Table K-2. The predicted levels by rollback model ($\mu g/m^3$).

Pollutant	2010	2015	2020
Geologic – original	12.3	12.9	13.4
Geologic - revised	13.8	15.1	16.2
Organic	7.5	8.1	8.6
Elemental Carbon	2.0	2.2	2.4
Ammonium Sulfate	1.9	2.0	2.1
Ammonium Nitrate	3.7	4.0	4.2
PM_{10}	35.5	38.3	40.8